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In This Issue

Tensile and Torsional Properties of Textile Fibers
L. G. Ray, Jr. 1

Equilibrium Moisture Relations for Textile Fibers
Richard K. Toner, Carol F. Bowen, and John C. Whitwell 7

Microscopical Methods in the Measurement of Swelling in Cotton Fibers: A Literature Survey
Mary L. Rollins 19

Apparatus for Determining the Coefficient of Friction of Running Yarn
Francis Breazeale 27

Use of Supersonics in the Preparation of Fiber Samples for Electron-Microscope Studies
A. Frey-Wyssling and K. Mühlethaler 32

Discussion of Published Papers 34

Book Reviews 35

List of Periodicals Abstracted 37

Abstracts 45

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TEXTILE RESEARCH JOURNAL

VOL. XVII, No. 1 January, 1947

Tensile and Torsional Properties of Textile Fibers*

L. G. Ray, Jr.

Rayon Department, E. I. du Pont de Nemours & Company, Buffalo, New York

THE primary purpose for determining the mechanical properties of fibers is to employ the results either for process control or for the prediction of fields of utility of new fibers. The present status of textile testing is such that its utility is limited almost exclusively to control, for normally tenacity and elongation of textile materials are measured and these data alone are used to describe the behavior or the quality of the product. In some cases, tensile strength data are supplemented by empirical tests thought to be connected with a specific property or combination of properties. These procedures are fairly reasonable as far as process control testing is concerned, but they are inadequate if one desires to predict from them the behavior of fabrics made from new or modified fibers, since, obviously, a fabric's utility as a textile is destroyed once the breaking point of the fibers is exceeded. Also, it is probable that many of the properties of a fabric depend not upon the load which the constituent fibers will support, but upon their not being permanently deformed under much smaller loads. Little information of this sort can be gotten from normal fiber tests.

The work covered by this report was undertaken for the purpose of determining the interrelationships of fiber and fabric properties so that it may eventually become possible to specify from fiber tests what textile uses can be served by new fibers and what types of fabric construction will most emphasize their desirable properties.

The problem of correlating fabric properties such as hand and resilience with fiber properties can be approached in several ways. The method employed in this study was to consider it as a problem in engineering; that is, to draw on engineering experience with construction materials such as iron, steel, and the like, and with this background to work out, at least to an approximation, the types of deformation and the extent of deformation which fibers in textile fabrics undergo. In Figure 1 are given the three major types of stress to which a fiber or other material may be subjected. Given also are the characteristic types of deformation which the materials exhibit in complying with these stresses.

Tensile stress is considered to result in a change in length. This change of length may be brought about by applying a force to pull apart the two ends of the material or a bending force to result in elongation on one side of the material and compression on the other side. When these deformations are small, bending can usually be considered as a combination of elongation and compression or pure tensile strain.

* Presented at the Gibson Island Meeting of the American Association for the Advancement of Science (July 10, 1946) and at the Joint Meeting of the Fiber Society and the High Polymer Physics Section of the American Physical Society at Charlottesville, Virginia (September 27, 1946).

A second type of stress to which materials are subjected is known as shearing stress. In one of the cases illustrated, stress is applied on the diagonals of a cube and the material, in complying with this stress, changes shape. In another case, a shearing (or torsional) stress is applied by holding one end of the material fixed and twisting the other about the axis of the sample.

Still a third type of stress is known as compressive stress and results in a change in volume. This

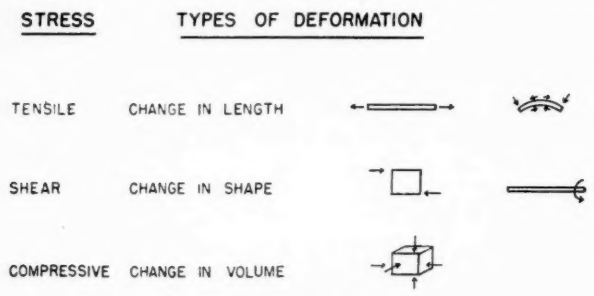


FIG. 1. *Types of stress.*

type of stress is normally encountered in connection with hydraulic problems in which pressures are the same on all surfaces of the material. The types of stress which one is likely to encounter in working with textile fibers are probably tensile in the sense of ordinary elongation and bending, and torsional in the sense that one is always working with a twisted multi-filament structure. In all probability, single fibers in fabrics are not subjected to pure compressive stresses.

Compliance to the various types of stresses is described classically by modulus values as shown in Figure 2. Degree of compliance to tensile stresses is determined by Young's modulus, $E = \frac{F}{A} \Big/ \frac{\Delta l}{l}$; compliance to shear by the rigidity modulus, $G = \frac{F}{A} \Big/ \phi$; and compliance to compressive force by the bulk modulus, $B = \frac{F}{A} \Big/ \frac{\Delta V}{V}$. It should be pointed out here that in engineering one is normally working with isotropic materials; that is to say, the properties of the materials are the same in all directions. In such cases, Young's modulus and the rigidity modulus of materials are related through Poisson's ratio, according to the equation: $G = \frac{E}{2(1+\sigma)}$. For most construction materials, Poisson's ratio (σ) is in the range of 0.2 to 0.5. It must be emphasized that the ratio of moduli is of significance only when the materials are isotropic. Owing to the process of manufacture, synthetic textile fibers are almost never structurally isotropic and therefore Poisson's ratio cannot be calculated from the modulus ratios. However, a comparison of Young's modulus and the rigidity modulus of fibers should give some information about the degree of anisotropy which is characteristic of them.

If textile fibers are to be considered in the light of the above engineering principles, it is further necessary to determine or to decide about *how much* deformation single fibers in fabrics would be expected to undergo. When it is considered that fabrics are normally made up of multi-filaments and that these multi-filaments are twisted to various degrees, it becomes quite difficult to calculate exactly the magnitudes of the deformation which are involved.

However, on the basis of a few assumptions, approximate values can be obtained by the method illustrated in Figure 3. Assuming a fiber to be bent around a radius of a certain value, and assuming further that the neutral axis of the fiber is at its center and that the deformation is equally divided between elongation and compression, the following calculation can be made: The length of arc AB is the neutral axis of the fiber and therefore represents its undeformed length. The amount of deformation in percent can be calculated from the lengths of arcs CD and AB. Geometrically, this elongation is given by pi times the radius of the fiber and the percent elongation is given by 100 times the radius of the fiber divided by the sum of the radius of the fiber and the radius of curvature around which it is bent. For example, if a fiber of 1-micron radius is bent around a curvature of

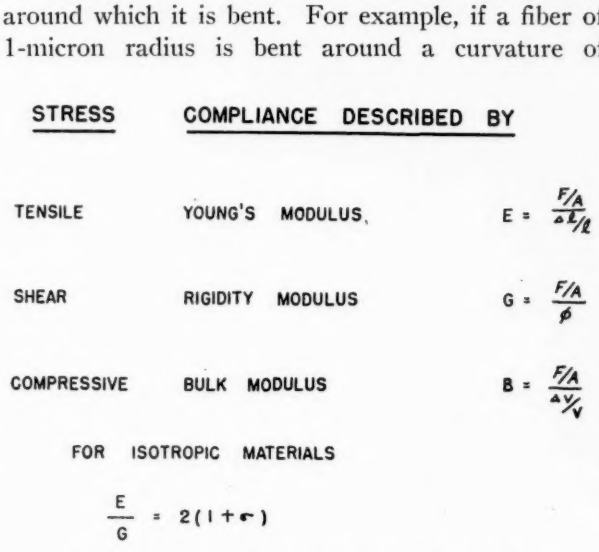


FIG. 2. *Compliance to various types of stress.*

100-micron radius, the resulting percentage of elongation or compression would be 1. With reference to any single fiber in a yarn, this is perhaps a fairly reasonable value.

As said before, it is impossible to estimate exactly the deformation undergone by fibers in fabrics. It is reasonable, however, to assume that this deformation is of a low order of magnitude, possibly in the region of 1 to 2 percent for most uses, although considerably higher deformations may be encountered in a sharp crease or compression. For the first investigations aimed at describing properties of fabrics such as resiliency, hand, etc., in terms of fiber properties, it was decided to study fibers in the range of 0.5 to 2 percent elongation.

Application of Experimental Methods to Fibers

Experimental methods for determining the physical properties of materials can be applied almost unchanged to a study of fibers except, of course, that the equipment involved is more delicate and the forces involved are very much smaller than those encountered in working with construction materials. Considerable apparatus for determining tensile properties of textile fibers has been marketed and is in wide use. However, in the past these instruments have not been designed to operate with sufficient sensitivity to allow study of the stress-strain behavior of single filaments at very low elongations. It was necessary in studying these properties to modify or refine types of equipment already available.

For a study of shearing properties of materials—exemplified in the case of fibers by torsional deformations—a simple classical method was employed. The fiber was used as a suspension for a torsion pendulum, and from the properties of the pendulum the elastic constants of the fiber were obtained [1].

For the sake of clarity, the remainder of this report is divided into two parts. In the first section the tensile properties of fibers will be described in some detail and in the second, torsional properties

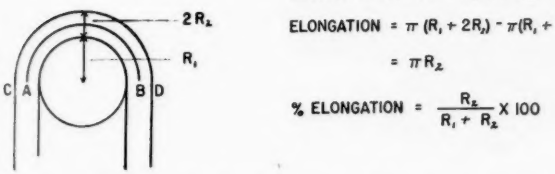


FIG. 3. *Idealized calculation of bending strain.*

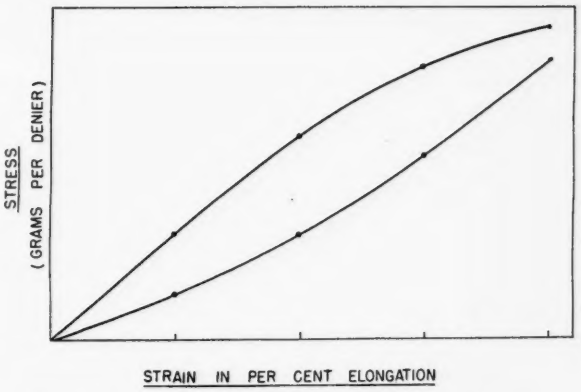


FIG. 4. *Typical stress-strain hysteresis curve.*

and their relationship to tensile properties will be discussed. All measurements were obtained at 70°F and 60 percent R.H.

Tensile Properties

The apparatus on which most of the tensile properties were determined was a modified chainweight balance, so equipped that single-filament samples could be elongated in the range of ½ to 3 percent and the stress necessary to produce this elongation could be determined to $^{2}/_{100}$ of a gram. At present, the same type of data is being obtained on an autographic tester based on the use of electromagnetic strain gages as stress-measuring and recording devices.

The original apparatus consisted of a chainweight analytical balance on which the left balance pan was replaced by a fiber clamp. The lower attachment for the fiber samples was fixed to the balance floor and was made adjustable so that samples from 2.5 to 20 cm. in length could be mounted between the clamps. A mirror was cemented on top of the fulcrum of the balance beam and a spot of light was reflected from this to a graduated scale at a distance of 1 meter. Sample elongation could be estimated from the displacement of the light spot when the balance was loaded and the fiber stretched. For small displacements, the ratio of fiber elongation to scale readings is approximately linear. In order to effectively cover the loading ranges required for various fibers, a series of calibrated chains was obtained to replace the standard 100-mg.-capacity balance chain. Loading was accomplished exclusively by use of these chains and resultant fiber elongations were read with the aid of the optical system with a precision of approximately ± 0.04 percent elongation.

In the preliminary work, tensile properties of single filaments were determined in the range of elongation from 0 to 2 percent. Figure 4 illustrates the type of data which were collected on these samples and represents an ordinary stress-strain curve, plotting stress in grams per denier and strain in percent elongation. The sample investigated was elongated stepwise with arbirtrary time units between each point on the stress-strain curve. After the fiber had been stretched the desired amount, it was then allowed to recover in a stepwise fashion and on recovery stress-strain readings were taken. From this type of data, the following properties may be determined:

1. Young's modulus—from the slope of the linear part of the elongation curve.
2. A value which has been defined as the recovery modulus—from the slope of the end of the recovery curve.
3. The amount of work necessary to elongate the fiber to the extent shown—from the area underneath the elongation curve.
4. The amount of work recovered from the fiber as it returns to its original form—from the area underneath the recovery curve.
5. An approximate value of the Hooke's law limit of the fiber.

For the purpose of condensing some of these data, the two work factors have been combined and reported as percent work recovery.

The tensile properties of a number of selected textile fibers are given in Figure 5. In the top half of the figure are charted the work-recovery values, which range from 95 for wool to about 60 for viscose rayon. In the lower half are given values of Young's modulus, which have a range from about 30 grams per denier for wool, casein fiber, and nylon, to approximately 100 grams per denier for silk. It is perhaps obvious that materials having a high capacity to recover work of deformation should be more resilient in the sense that they lose less work in going through an elongation-recovery cycle than do fibers with low work-recovery capacities. This relationship is borne out by comparison of work-recovery values in the figure. The primary standard of textile resilience—that of wool—is characterized by a high value of work recovery. Casein fiber, which in fabric form approximates the behavior of wool, is also characterized by a high value of this constant, whereas materials which do not show as good resiliency in the form of fabrics, such as nylon and viscose rayon, are characterized by poorer values of the work-recovery ratio.

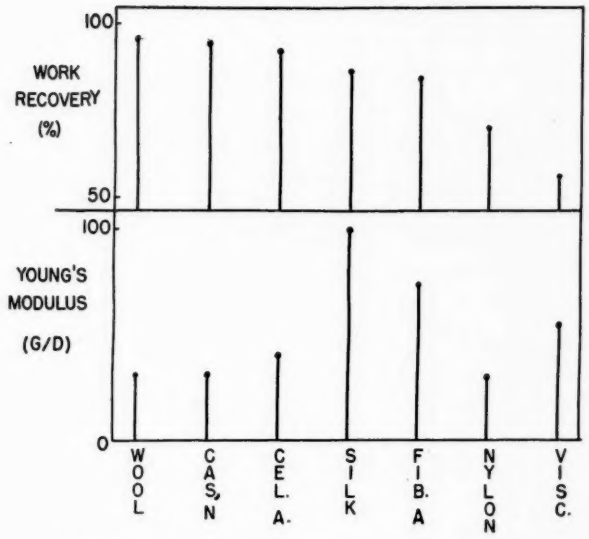


FIG. 5. *Tensile properties of textile fibers.*

Tensile properties of fibers may also be discussed in terms of resistance to deformation or Young's modulus values. Wool, casein, and cellulose acetate fibers are characterized by low values, which mean great compliance to small stresses, while materials like silk have high modulus values and therefore would tend not to be deformed as greatly under a given set of conditions as would materials of the former type. A combination of these fiber properties, Young's modulus and work recovery, can be used to predict to some extent the general behavior of textile fabrics. It is, of course, true that geometrical factors and other mechanical properties partially determine the type and magnitude of the de-

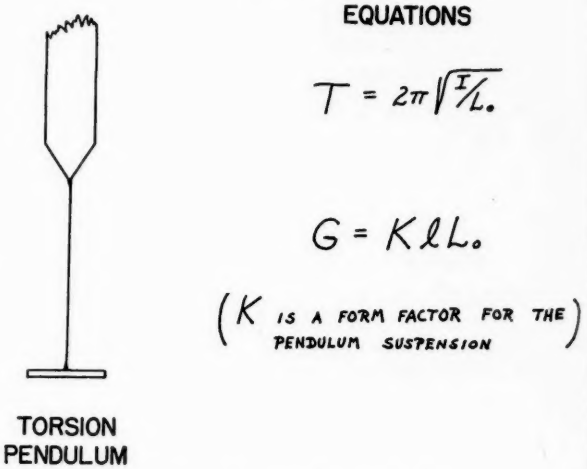


FIG. 7. *The torsion pendulum.*

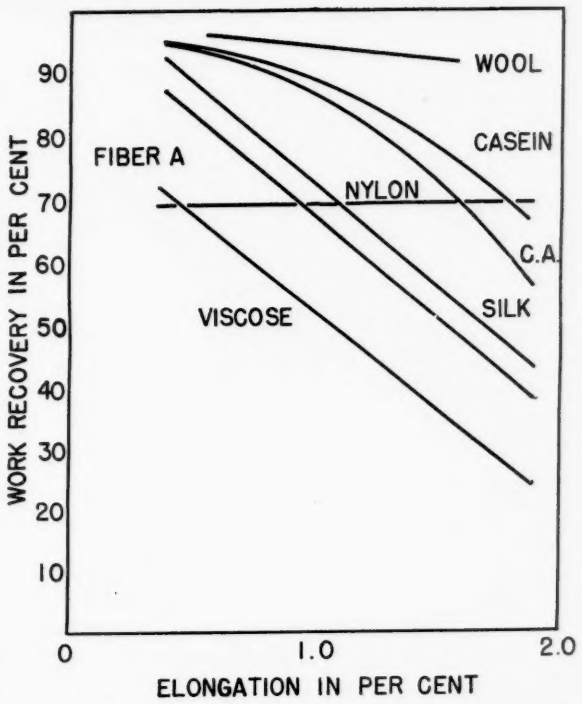


FIG. 6. *Dependence of work recovery on elongation.*

formation which a fiber will undergo under a given set of conditions, and the effects of these other factors must always be taken into consideration in any discussion of the relationship of fiber to fabric properties.

Generally speaking, and considering constituent fibers to be of comparable sizes, materials with a soft hand are characterized by low values of Young's modulus, while materials having a harsh or crisp hand are characterized by high values. It is well to point out in this connection that tensile-property measurements allow a classification of resilient materials into two types: On the one hand are materials like wool which have a high capacity to recover work of deformation and low resistance to deformation, while on the other hand are materials like silk which have a relatively low capacity to recover work but present considerable resistance to deformation. In this connection also the similarity in the fiber properties of silk and Fiber A (Figure 5) should be noted. Fabrics made from these two materials are much alike and such a result would have been predicted from a knowledge of their work-recovery and modulus characteristics.

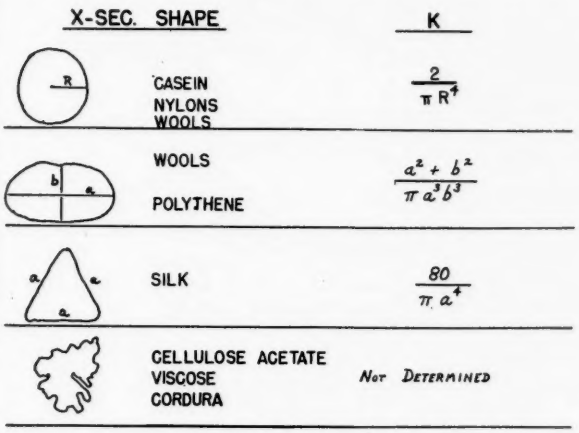


FIG. 8. *Form factors for materials of different cross sections.*

The values given in Figure 5 were all determined at an elongation of 0.75 percent, but, as would be expected, work recovery is markedly dependent on the extent of deformation of the fiber. The magnitude of this dependence is given in Figure 6, in which are plotted work recovery in percent versus maximum fiber elongation in percent. Here again the general outlines of correlation of work recovery with resilience are noticeable. The behavior of wool puts it in a class almost alone, whereas that of silk is decidedly different. Here, again, the behavior of Fiber A and silk are parallel and intermediate between the behavior of truly resilient fibers like wool and nonresilient fibers like viscose rayon.

The position of nylon in the preceding figure is of considerable interest because its work-recovery capacity at low elongations is relatively poor, whereas at high elongations it becomes one of the best of the fibers studied. The independence of work recovery and elongation in this case is thought to be due to the strained condition of the fibers previous to testing, although nylon which has been previously relaxed by treatment with hot water shows somewhat the same type of behavior, except that under these conditions some small dependence of work recovery on elongation can be noted.

On the basis of the results reported here, one would say that a reasonably good correlation of resilience with work recovery and modulus has been obtained. However, in some cases, notably that of modified nylons, fibers have been found which have high work-recovery capacity and yet in the form of fabrics produce materials of relatively low resiliency. This result was not unexpected, but it serves to emphasize the fact that properties other than tensile ones are involved in fabric deformations.

Torsional Properties

The classical methods for determining the torsional or rigidity modulus of materials are easily

applicable to textile fibers, particularly since in recent years it has been possible to prepare synthetic fibers having uniform cross sections. The technique which was used in the determination of the values given here was based upon using single fibers as suspensions for torsion pendulums and measuring the characteristics of the pendulum.

The equipment and procedure for determining torsional moduli are relatively simple. A light aluminum disc is attached to a heavy support by a length (l) of the fiber to be tested and the pendulum so prepared is forced into torsional oscillation and its period (T) is determined. From the pendulum period the force constant (L_0) of the pendulum suspension and the rigidity or torsional modulus (G) of the fiber can be calculated by the equations given in Figures 7 and 8. The K factor in Figure 7 is a form factor for the pendulum suspension and depends upon the cross-section shape of the suspension material. Representative cross-section shapes and corresponding K values are given in Figure 8.

From these data, it has been possible to calculate rigidity moduli in dynes per square centimeter for various fibers. Representative results are given in Figure 9, in which wool is characterized by a rigidity value of 1.7×10^{10} dynes/cm^2, while polythene, the least rigid material studied, has a value of 0.3×10^{10} dynes/cm^2. According to Peirce [1], cotton fibers have rigidity values of about 2.2×10^{10} dynes/cm^2 at 60 percent R.H.

Recently in our laboratories direct measurements of torsional and rigidity moduli have been made and have been found to agree in most cases with the values determined by the pendulum technique.

It is interesting to point out that in terms of chemical structure, these rigidity values probably reflect the strength of the interchain forces of oriented materials. For example, wool which is chemically cross-linked has a relatively high value, while nylon, which is characterized by long hydrocarbon chains between lateral planes of linkage, is characterized by low rigidity, almost in the range of that determined for polythene, which consists of hydrocarbon chains and depends for its rigidity on the packing of these chains.

Earlier in this discussion, it was stated that fibers are by nature anisotropic and it was suggested that a rough measure of anisotropy might be obtained if the magnitudes of the rigidity modulus and the Young's modulus of a material were compared. The values for Young's modulus in Figure 9 were calculated from the values given in grams per denier presented previously, and the ratio of Young's modulus to the rigidity modulus is considered to be a measure of the relative ease with which a fiber can be stretched or twisted; high values indicate great anisotropy and low values indicate slight anisotropy. These statements are true if Poisson's ratio is in the range of 0.5.

FIBER	G(DYNES/CM^2)	E(DYNES/CM^2)	E/G
WOOL	1.7×10^{10}	3.4×10^{10}	2.0
CASEIN	1.3	2.9	2.2
SILK	1.2	13.9	11.5
CELLULOSE (UNSTRETCHED)	1.4	5.0	3.5
(STRETCHED)	1.6	17.1	10.5
NYLON	0.4	2.4	6.0
POLYTHENE	0.3		

FIG. 9. *Comparison of rigidity and Young's moduli for textile fibers.*

The ratio of E/G furnishes another opportunity to make a distinction between materials like silk and materials like wool. Silk-like materials are characterized by high values of this anisotropy ratio, whereas wool-like materials are characterized by low values. It is interesting to point out that in the case of cellulose, orienting the material by stretching results in a large increase in Young's modulus but a relatively minor increase in the rigidity modulus so that the anisotropy factor is increased markedly by the stretching treatment. The resulting fibers are more silk-like in their resistance to longitudinal deformation than unstretched ones, but their actual work-recovery capacities from any given deformation are not improved.

Summary

An attempt to correlate fiber properties with the behavior of textile fabrics has been made. Fibers were considered to be specialized materials of construction, and their properties were investigated in terms of engineering principles. Tensile and torsional properties of textile fibers have been measured and related in a general way to fiber structure and to fabric properties such as resiliency and hand.

Literature Cited

1. Peirce, F. T., *et al., J. Text. Inst.* **14**, 1 (1923); **20**, 315 (1929).

Equilibrium Moisture Relations for Textile Fibers*

Richard K. Toner,† Carol F. Bowen,‡ and John C. Whitwell**

Contribution of the Textile Research Institute and the Department of Chemical Engineering, Princeton University

It is the purpose of this paper to present data on equilibrium moisture based upon the published work of Wiegerink [4] statistically recalculated by the present authors. The study was first undertaken in the belief that Wiegerink's data could be made more useful if his curves of equilibrium moisture versus relative humidity could be extended with respect to temperature and relative humidity ranges and if the experimental variations in the data could be accurately minimized. In the analysis it was found that characteristic results for fibers could be explained in terms of physical-chemical principles which were presented and discussed in the first paper of this series [3]. The second publication [1] presented the mathematical details of the statistical correlation method.

History of Samples

It must be emphasized that the information presented in the accompanying figures represents the correlation for specific samples with definite histories. It cannot be expected that other samples with different case histories will give exactly the same results even if they have been conditioned to the same equilibrium temperature and relative humidity. Therefore, these curves must be accepted only as representative of the types of fibers studied. In a subsequent paper in this series a method will be presented by which the moisture-regain curve of a sample similar to any one of those presented here can be obtained with relative simplicity.

Discussion of Results

The curves on the accompanying figures are those determined by the statistical recalculation method whereas the points are the experimental data of Wiegerink. The deviation of the points from the lines serves to indicate roughly the extent to which any item of data, taken under identical experimental conditions, may deviate from the statistically smoothed curves and offers visual evidence of the suitability of the method. Special reference should be made to the 125°C and higher-temperature isotherms. These gave the most trouble in recalculation because the majority of the experimental points fell outside the region susceptible to the method used; therefore these lines had to be determined by extrapolation methods which have not as yet been presented. The next paper in this series will discuss them. It is sufficient to state at this time that it was nearly always possible to predetermine a line consistent with the original data by using extrapolation methods based on theories previously developed. There is great need for additional low-moisture data to substantiate these theories. The present scarcity of such data makes a generalized correlation in this region difficult. There were one or two instances (notably viscose rayon in sorption) in which it was impossible to get reasonable agreement between the points and the correlated line. There are two explanations for such a failure: one is incorrect experimental data and the other is omission from the correlation method of some factor pertinent in these instances and not in others. Without additional experimental evidence it is impossible to state which of these postulates is true.

It seems worth while to note further that a few of the fiber systems studied do not give high "confidence" in the existence of a common point of in-

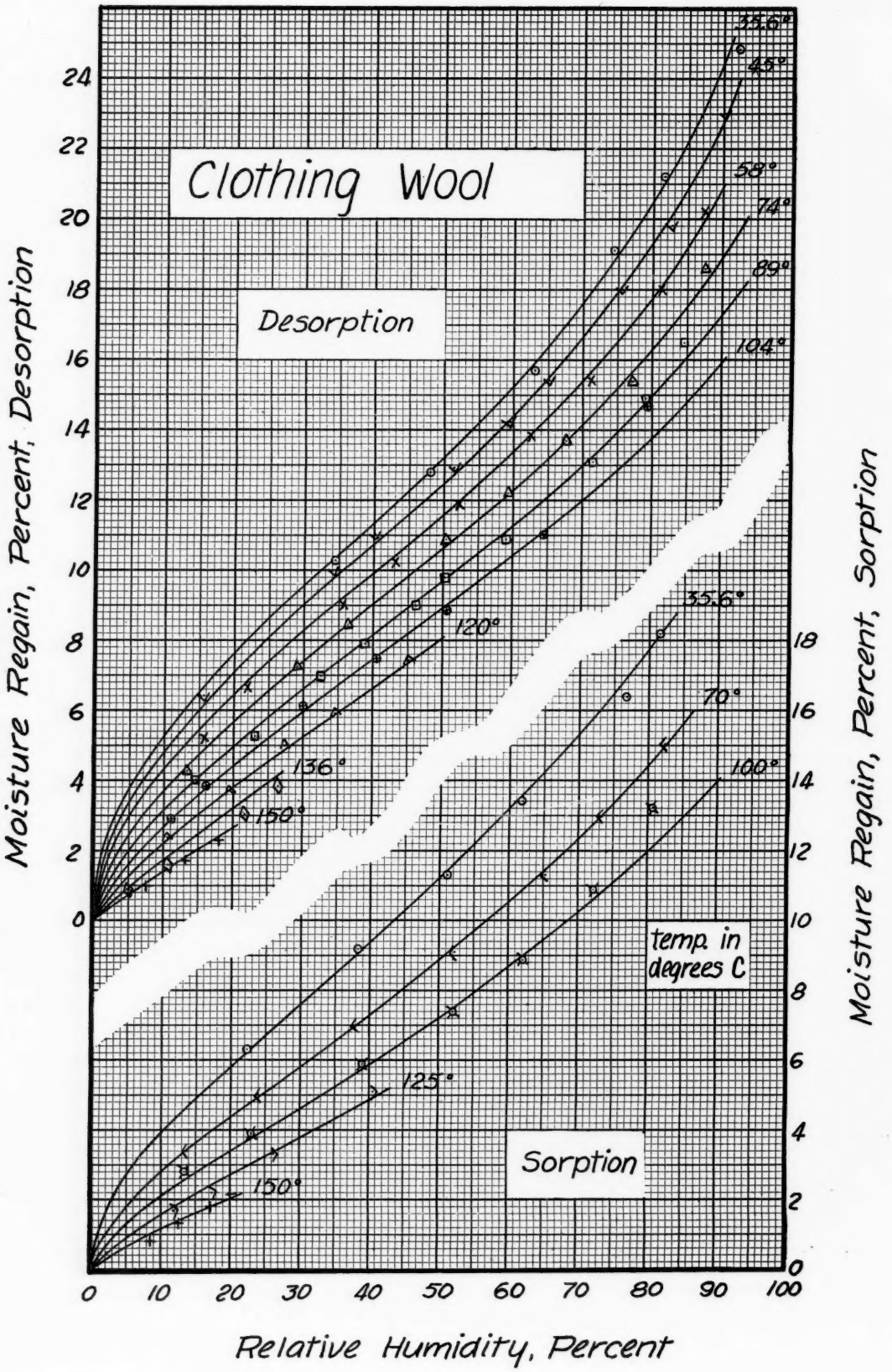
[*Continued on page 14*]

* This paper is the third of a series. The previous papers appeared in the June and July, 1946, issues of this journal. A fourth paper entitled "Predicting Equilibrium Moisture Relations, with Particular Reference to Textile Fibers" will appear in the February issue.

† Member of Textile Research Institute Staff and Assistant Professor of Chemical Engineering, Princeton University.

‡ Member of Textile Research Institute Staff.

** Associate Director of Research, Textile Research Institute, and Professor of Chemical Engineering, Princeton University.


Clothing Wool
Desorption
Sorption
35.6°
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89°
104°
120°
136°
150°
35.6°
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temp. in degrees C
Moisture Regain, Percent, Desorption
Moisture Regain, Percent, Sorption
Relative Humidity, Percent
0 2 4 6 8 10 12 14 16 18 20 22 24
0 10 20 30 40 50 60 70 80 90 100

FIG. 1.

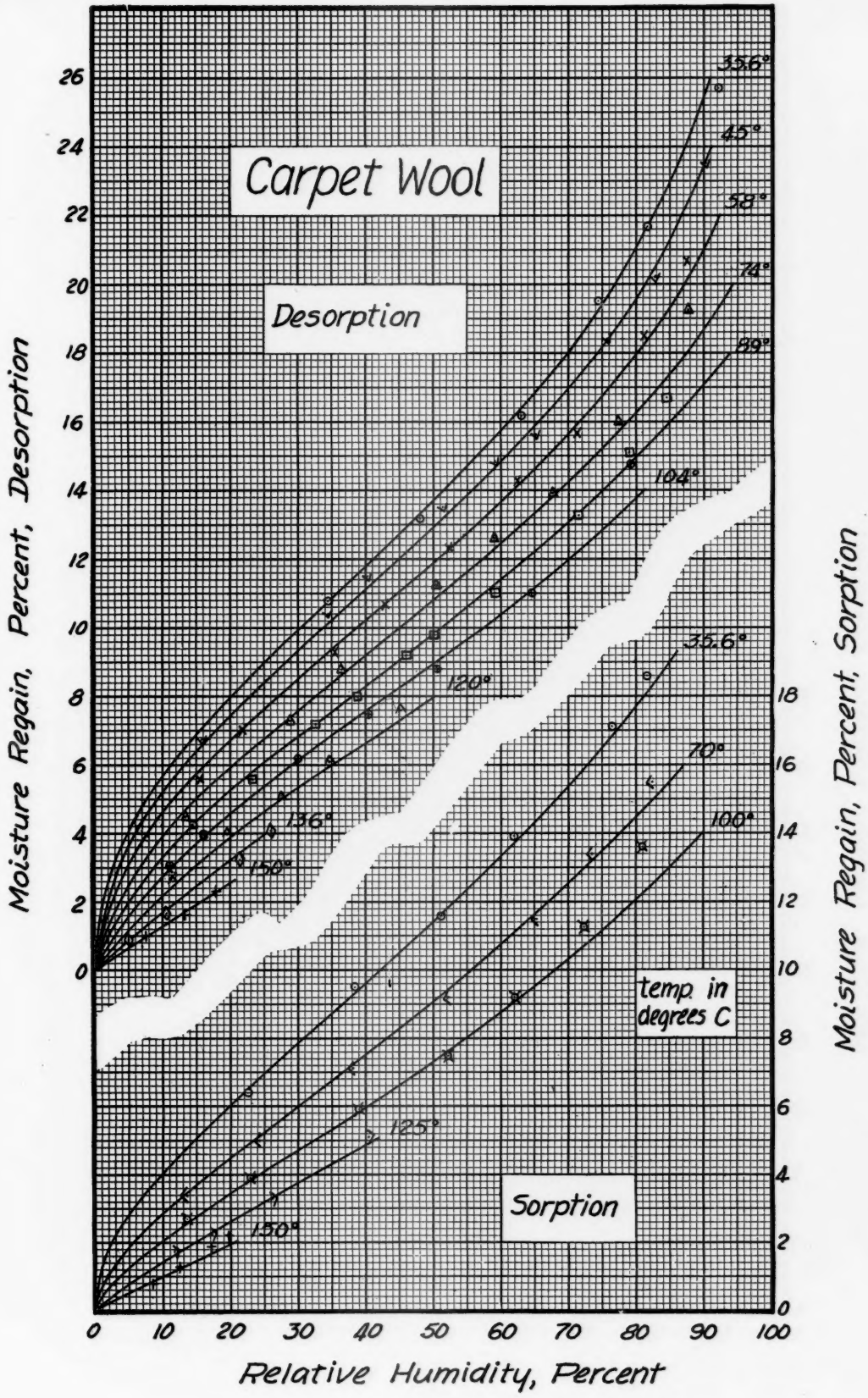
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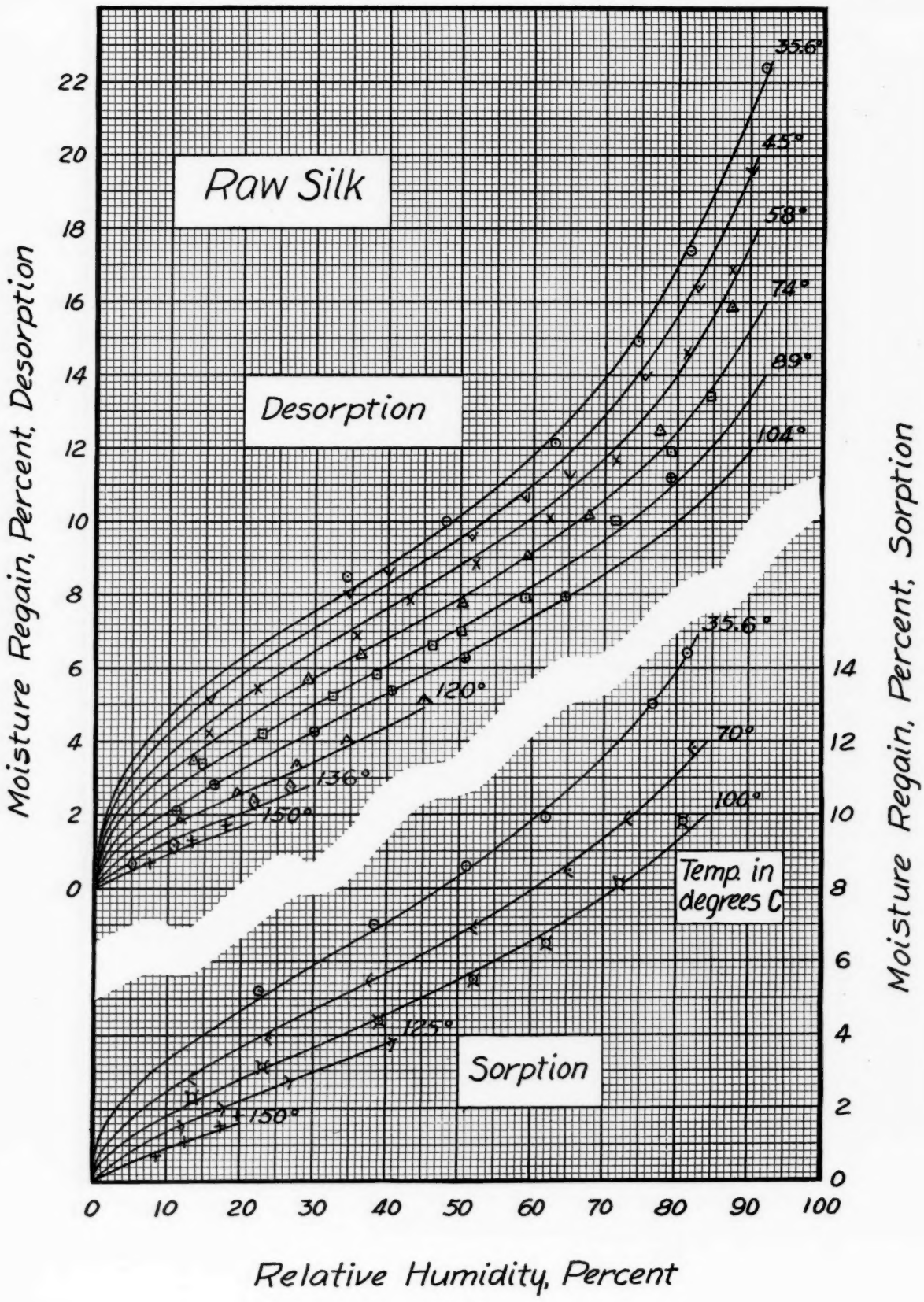
FIG. 2.


Raw Silk
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Moisture Regain, Percent, Sorption
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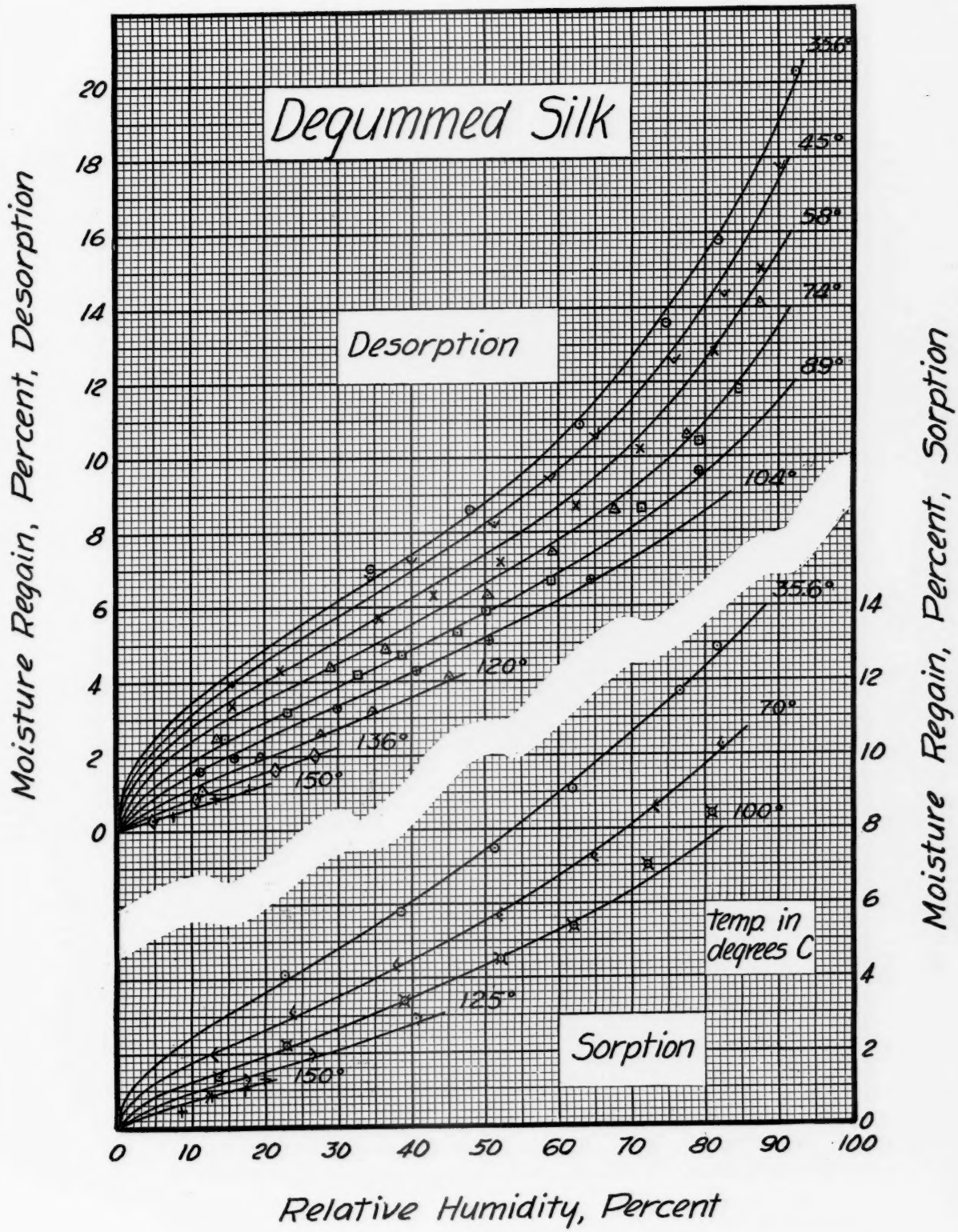
FIG. 3.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150°
temp. in degrees C
Moisture Regain, Percent, Desorption
Moisture Regain, Percent, Sorption
Relative Humidity, Percent
0 10 20 30 40 50 60 70 80 90 100
0 2 4 6 8 10 12 14 16 18 20

FIG. 4.

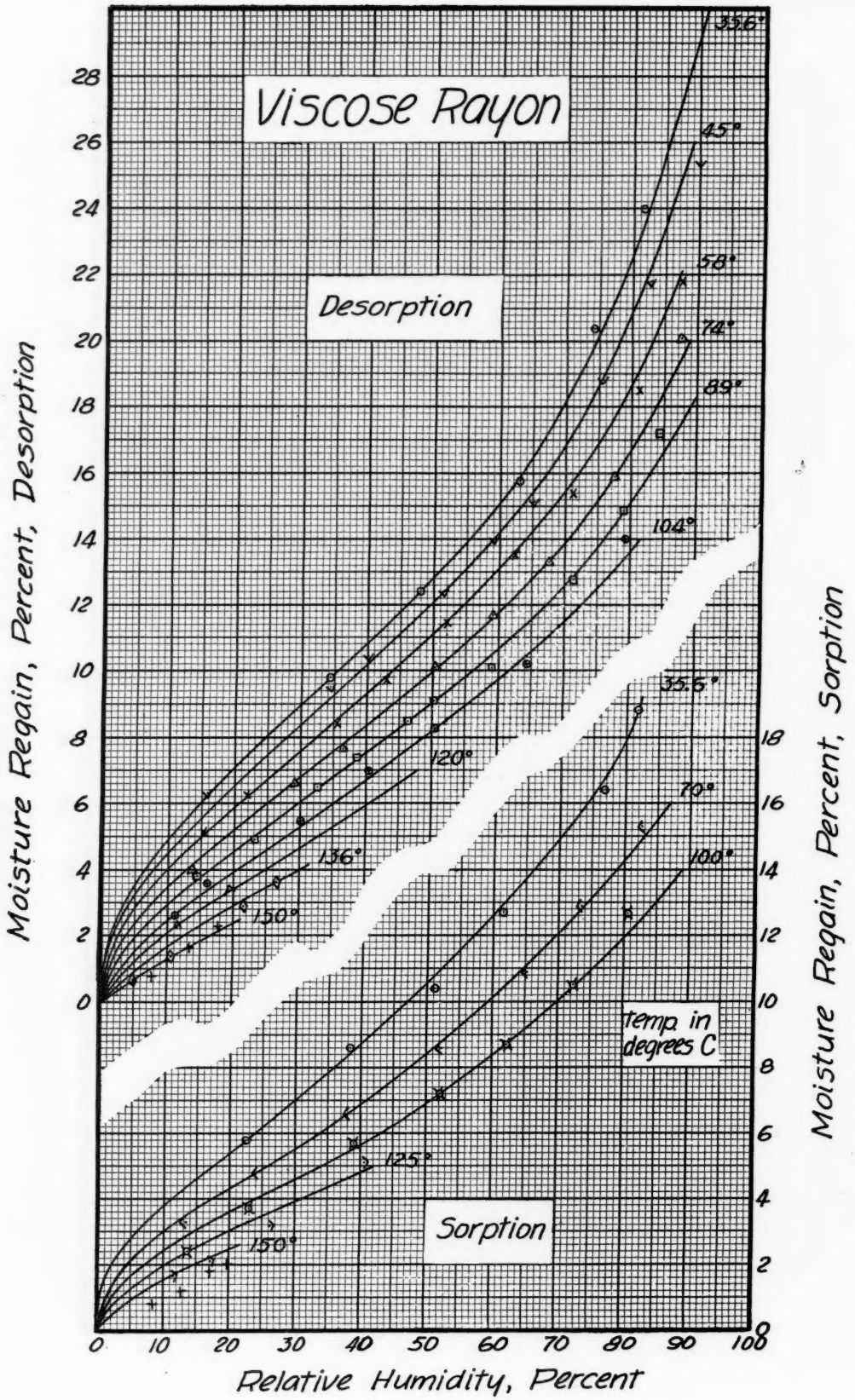
Viscose Rayon
Desorption
Sorption
35.6°
45°
58°
74°
89°
104°
120°
136°
150°
35.6°
70°
100°
125°
150°
temp. in degrees C
Moisture Regain, Percent, Desorption
Moisture Regain, Percent, Sorption
Relative Humidity, Percent
0 10 20 30 40 50 60 70 80 90 100
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28

FIG. 5.

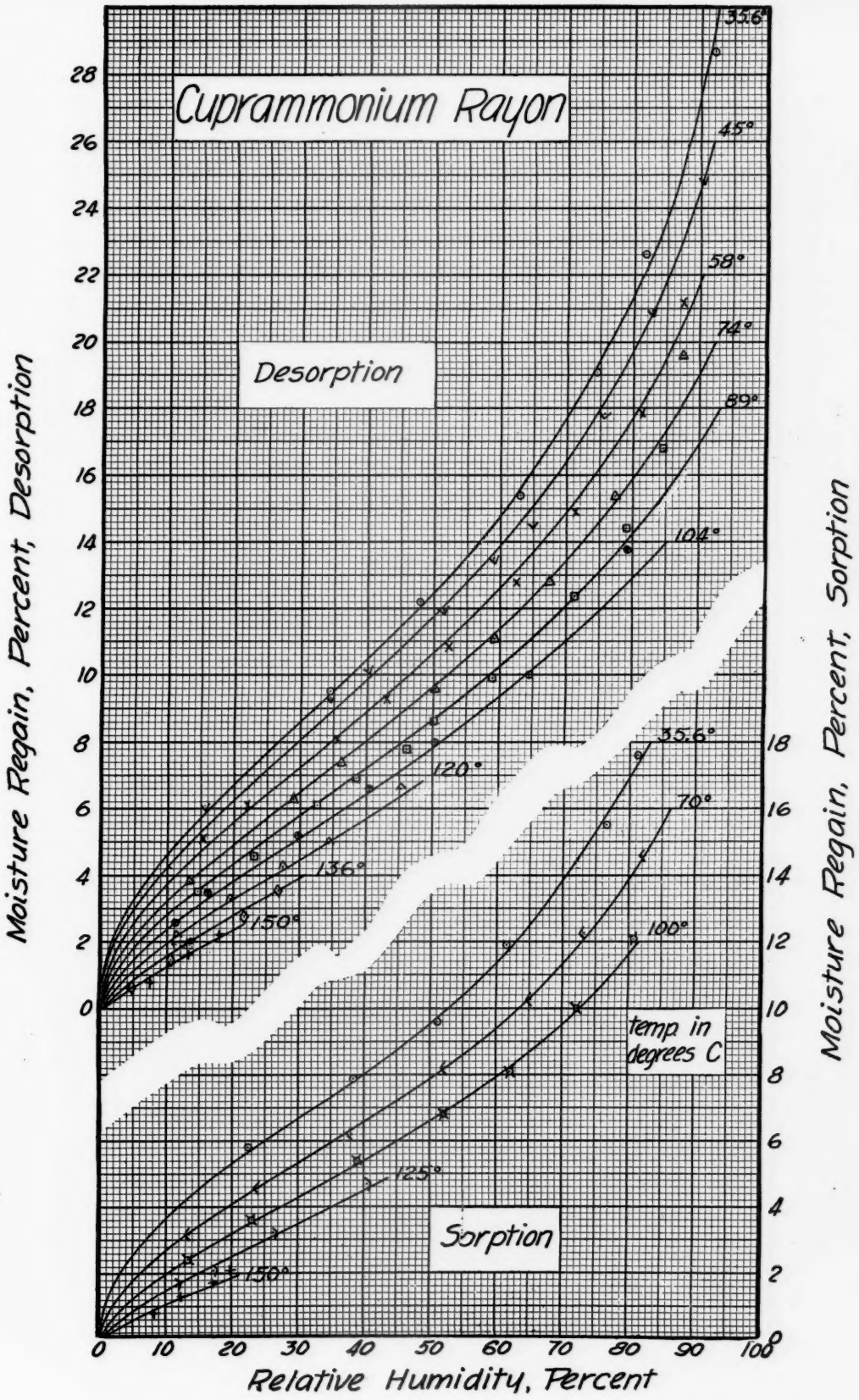
Cuprammonium Rayon
Desorption
Sorption
35.6°
45°
58°
74°
89°
104°
120°
136°
150°
35.6°
70°
100°
125°
150°
temp. in degrees C
Moisture Regain, Percent, Desorption
Moisture Regain, Percent, Sorption
Relative Humidity, Percent
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28
0 10 20 30 40 50 60 70 80 90 100

FIG. 6.

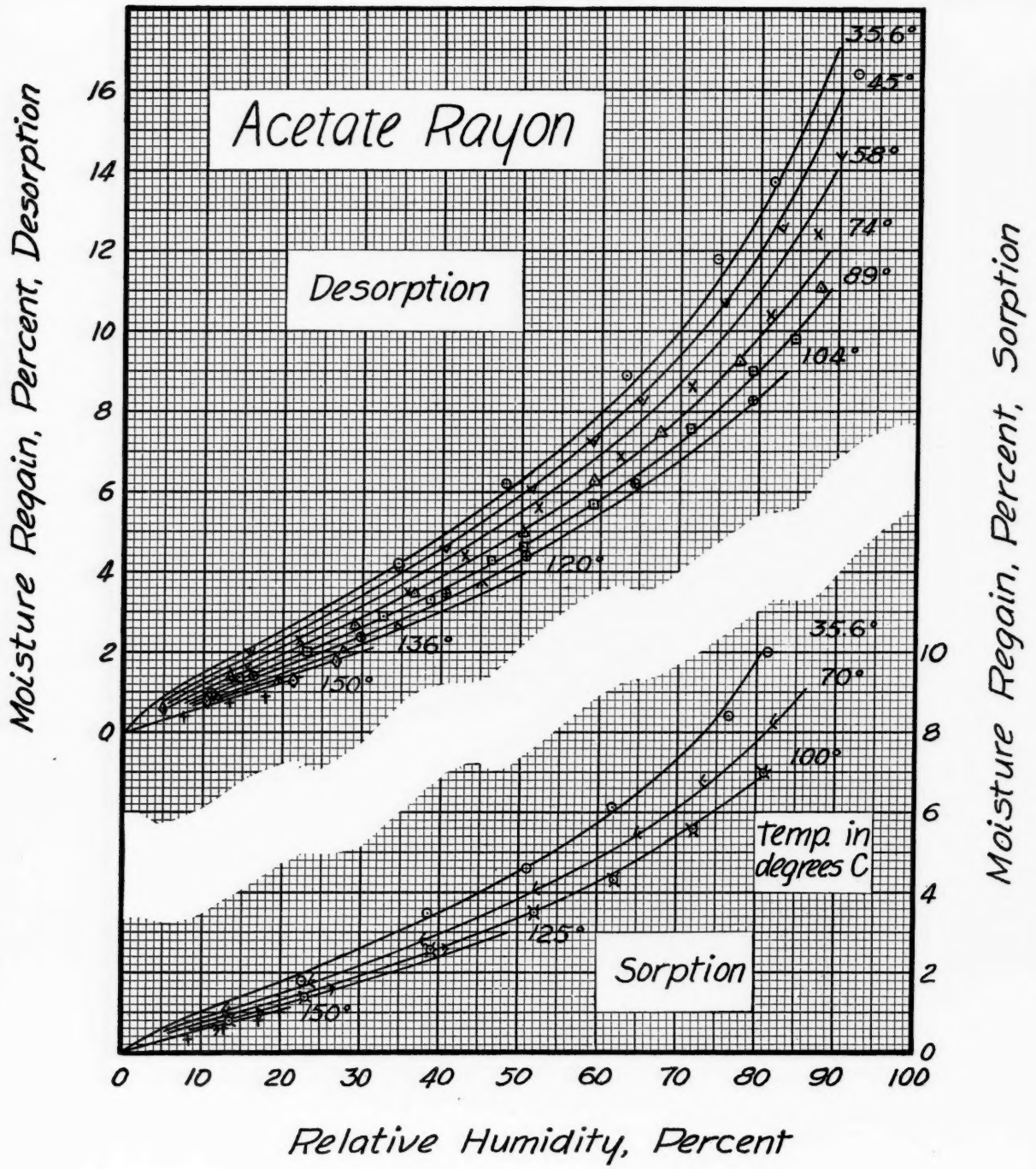

FIG. 7.

[*Continued from page 7*]

tersection of the isosteres (constant composition lines). Despite this fact, the recalculated isotherms for cuprammonium rayon, which so classifies, show almost perfect agreement with the experimental data, while for acetate rayon, on which the "confidence level" is high, the points are not so closely related. This apparent anomaly may be explained as a function of the agreement of the experimental points on the individual isosteres with the Othmer relation used to characterize the temperature-pressure relation. If these points are essentially perfect (that is, if there

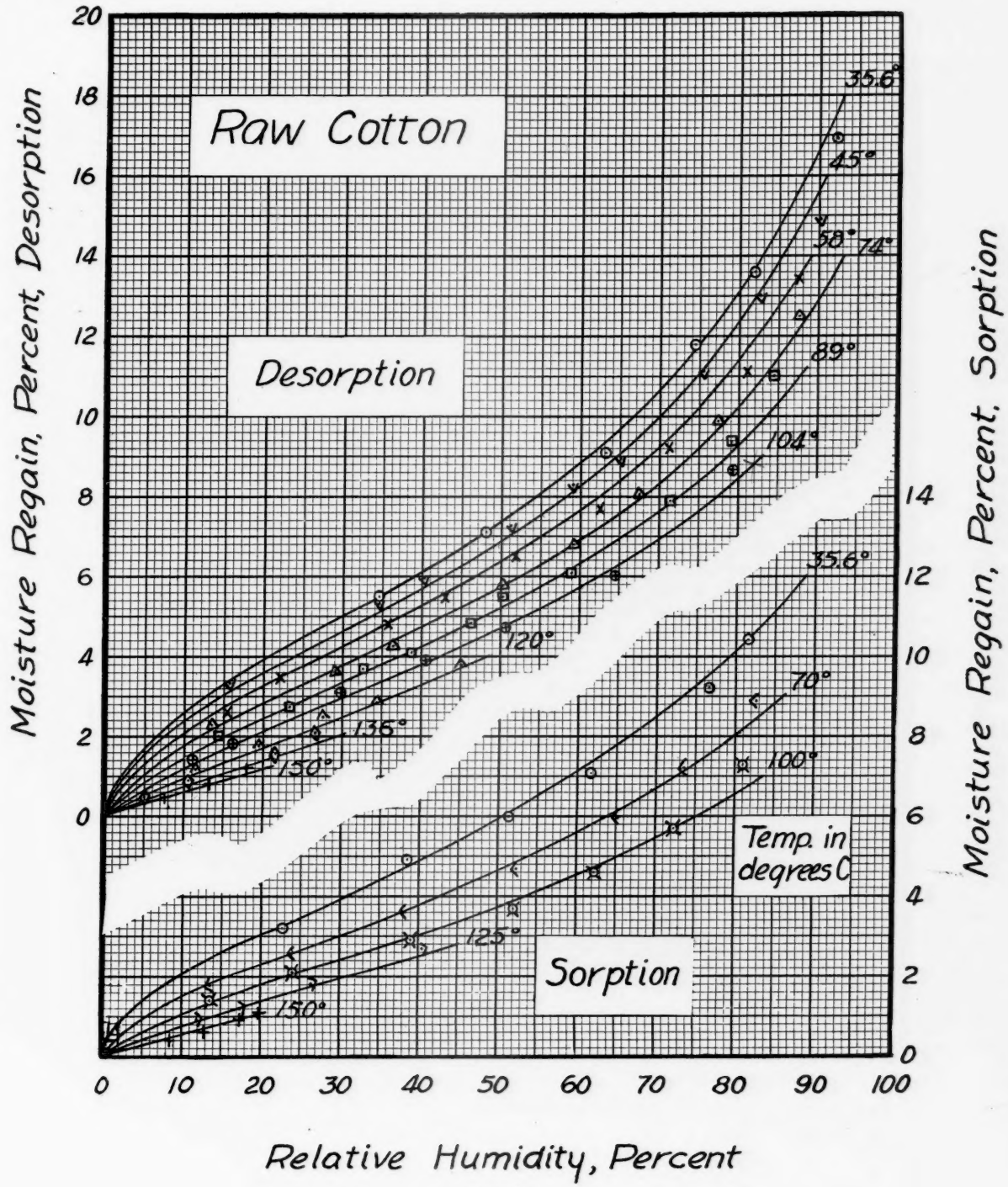

FIG. 8.

is a very low least-squares deviation for the system), imposing an additional restriction (for example, a common point) may easily increase the variance of the system beyond the range of extreme statistical probability. This appears to be true in the case of cuprammonium rayon. For data less carefully taken or where the experimental techniques were not so well-established, the greater least-squares deviation allows the imposing of a greater variance, owing to the additional restriction without departure from the realm of probability (that is, with the production of extreme "confidence" in an intersection). This

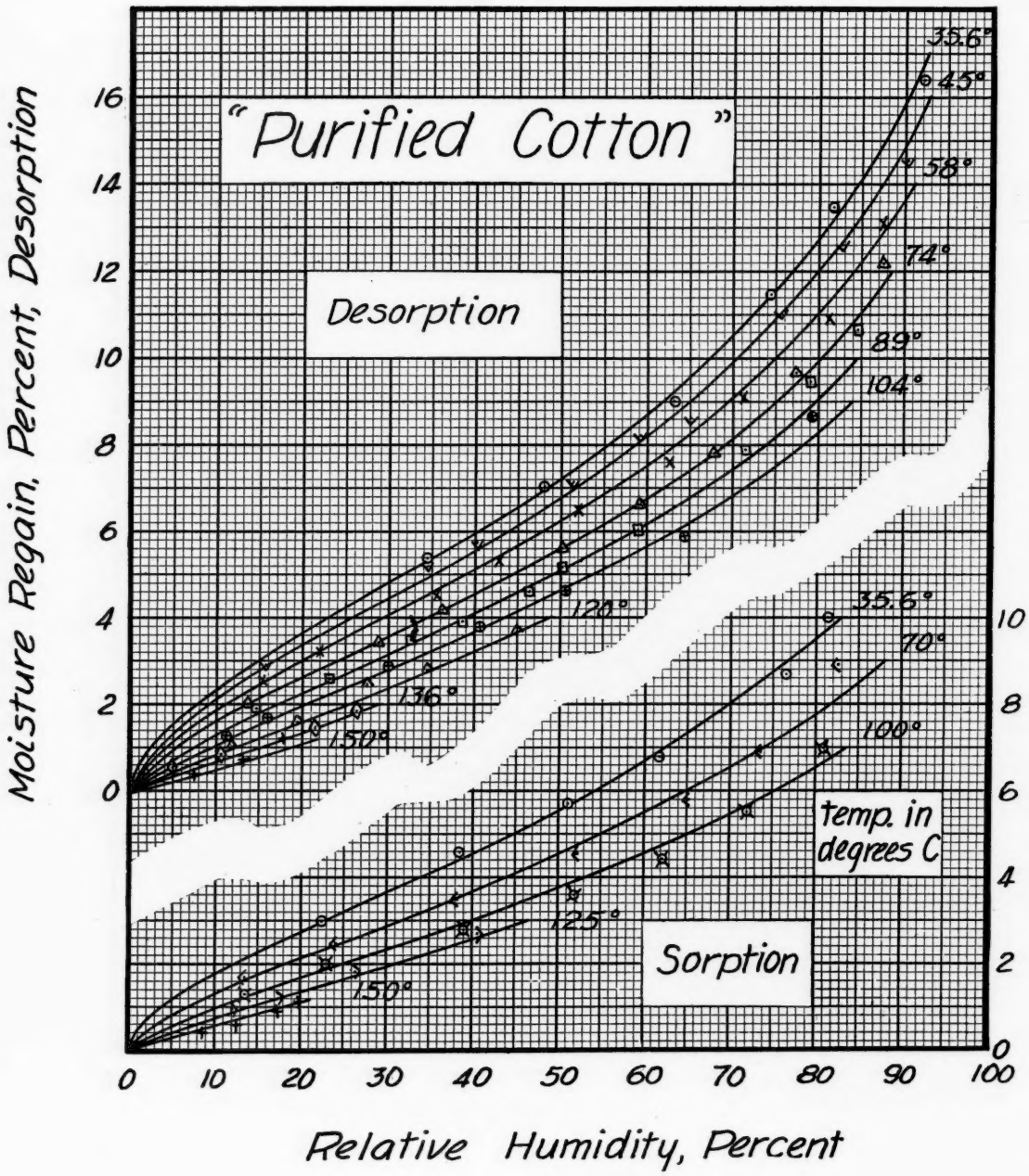

FIG. 9.

case is that of acetate rayon. As explained in the second paper [1], the confidence levels are not perfectly evaluated because of some measure of non-homogeneity of variance. This fact, coupled with the very good "confidence" in a large majority of the cases studied, regardless of the character of the data, has been assumed to be satisfactory evidence that the method may be universally applied.

Graphical Presentation

The figures are reproduced here in more detail than those accompanying the original data in order that information may be obtained from them more easily. The larger size is justified by the additional accuracy obtained by the statistical correlation method. In addition to the data of Wiegerink, Urquhart and Williams' data on soda-boiled cotton

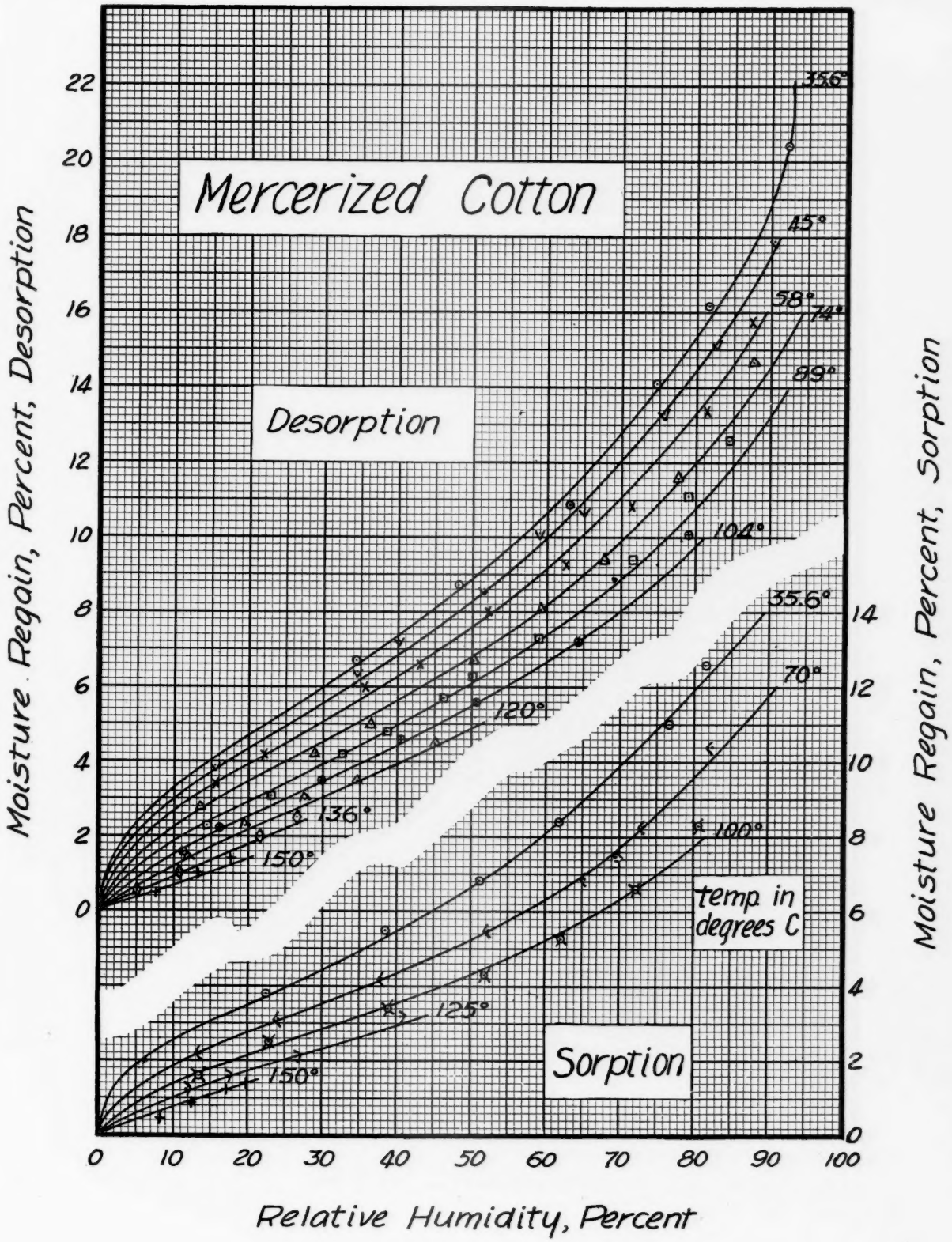
Mercerized Cotton
Desorption
Sorption
35.6°
45°
58°
74°
89°
104°
120°
136°
150°
35.6°
70°
100°
125°
150°
temp. in degrees C
Moisture Regain, Percent, Desorption
Moisture Regain, Percent, Sorption
Relative Humidity, Percent
0 10 20 30 40 50 60 70 80 90 100
0 2 4 6 8 10 12 14 16 18 20 22
0 2 4 6 8 10 12 14

FIG. 10.

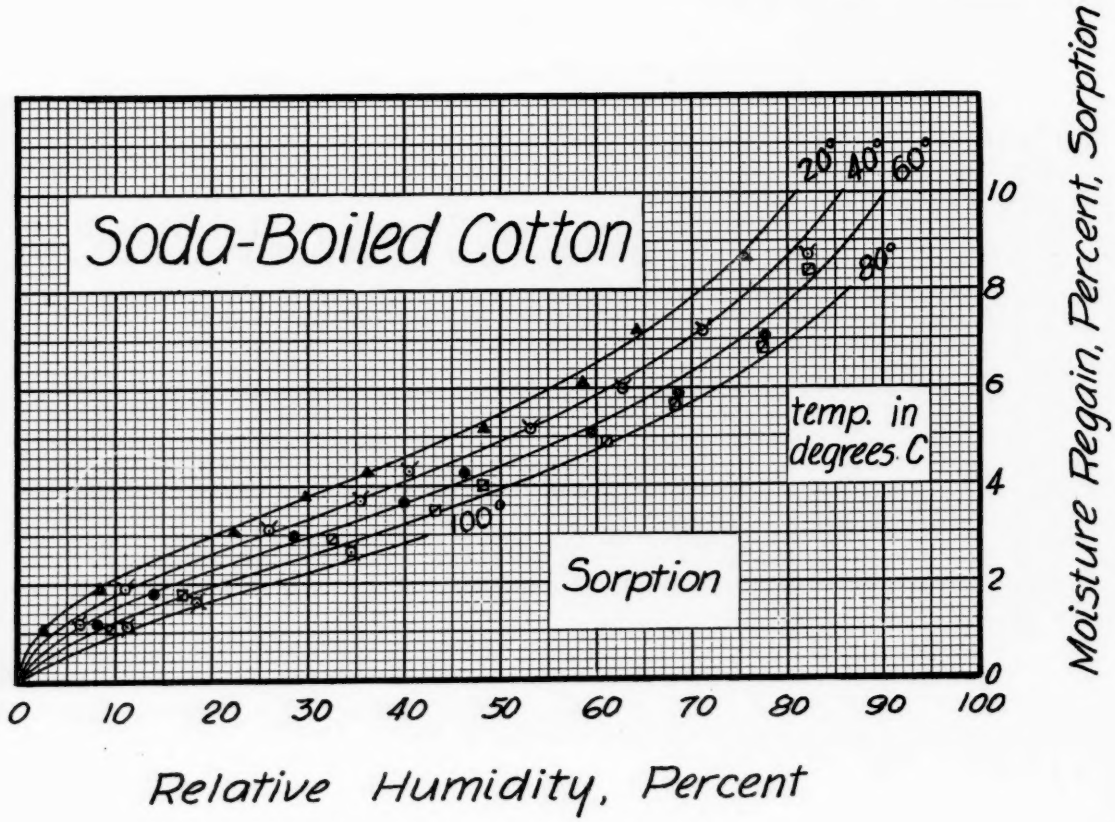

FIG. 11.

[2] were subjected to statistical study and are included.

Summary

The curves presented here represent a statistical correlation of moisture-equilibrium data. The data are correlated not simply from the point of view of an individual isotherm or even from the broader aspect of a single fiber, but, rather, in a fundamental sense, from the standpoint of a basic theory encompassing all textile materials. They are presented in the belief that they represent the most probable values for a set of consistent experiments but with the knowledge that no other actual fiber is likely to agree with them exactly because of variation in such respects as previous history.

Acknowledgment

The authors are particularly grateful to Dr. A. C. Walker, of the Bell Telephone Laboratories, for making available not only the original data but many preliminary calculations based on them and for his encouragement during the course of this study. They also wish to extend appreciation to J. W. Tukey and P. J. McCarthy of the Princeton University Mathematics Department for their invaluable aid in the statistical analysis of the data.

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4. Wiegerink, J. G., TEXTILE RESEARCH **10**, 357 (July 1940).

Microscopical Methods in the Measurement of Swelling in Cotton Fibers: A Literature Survey

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Introduction

In connection with a project for the study of water-resistant fabrics and their swelling characteristics, a survey of the literature on the swelling of individual cotton fibers was deemed useful.

Swelling may be broadly defined as the increase of volume of a solid upon sorption of a liquid. Most textile fibers have this property to a greater or less degree and the fact that changes occur in the diameter of their cross sections when subjected to water or other liquids is well known. According to Katz [18], "A solid is said to *swell* when it takes up a liquid, whilst at the same time (*a*) it does not lose its apparent (microscopic) homogeneity; (*b*) its dimensions are enlarged; and (*c*) its cohesion is diminished: instead of hard and brittle, it becomes soft and flexible. Only when all three of these conditions are fulfilled may we say that real swelling occurs."

It has long been known that the increase in length of cotton fibers from the air-dry state to saturation in water is about 1 percent. In view of this negligible increase the change in length may be ignored and it may be considered that the swelling of fibers is adequately indicated by changes in diameter. This review is confined strictly to those works in which is discussed the microscopical measurement of cotton-fiber ribbon width or cross-sectional area with emphasis upon its use in the investigation of dimensional changes in the fiber due to absorption of liquids. No attempt has been made to include any of the papers dealing with indirect measurements of swelling such as specific gravity, volume change, or increase in weight; nor is there included here any of the voluminous literature on the solvation or partial solvation of cellulose fibers for the purpose of demonstrating microscopical structure.

There is, unfortunately, little work dealing specifically with the swelling of untreated cotton in water. A great deal of the material in the literature has to do with the swelling of fibers which have been pretreated by mercerizing, soda-boiling, scouring, or bleaching for the particular purpose of the individual investigator's problem, and with the swelling phenomena incident to mercerization. By far the greater part of the literature on microscopical measurement of fibers deals with the swelling of cellulose in the alkali metal hydroxides.

Because of the scant information on the swelling of untreated fibers, few data can be quoted directly. The figures given in the literature for dimensional increase due to swelling cannot be compared satisfactorily, for few samples discussed have had the same pre-histories or have been measured under identical conditions. In fact, most of the authors have given no adequate account of the history of the sample either with respect to pretreatment, such as extraction, kier-boiling, bleaching, or mercerization, or to natural history, such as degree of maturity, variety, region of growth, climatic environment, ginning treatment, or cleaning. In the majority of investigations here discussed the swelling reported is based on the increase in ribbon width in complete disregard of the known irregular shape of the cotton fiber, the presence of the lumen, and the variations in maturity of fibers. In most cases swelling is calculated only as increase in ribbon width and reported as such, but a few of the investigators have used the measured ribbon width as a diameter on which to calculate increase in area, as if the fibers were actually circular or elliptical in cross section. This latter assumption is not so egregious as it would at first appear. In nearly all investigations

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the measurements were not made on raw cotton fibers but on samples which had been pretreated with caustic soda of at least 15 percent strength, so that the fibers of the sample were in fact not raw but mercerized, and their cross sections were more nearly elliptical or round than flat. It is still a just criticism that these investigations do not measure the dimensional changes of natural cotton fibers due to wetting in water and that no account is taken of the wide variation of shapes, wall thicknesses, and lumen sizes to be found in any untreated sample of cotton. However, because of the very closely allied techniques used in the investigations reported, the methods of attack are useful for the further pursuit of the problem in hand and results are indicative of certain characteristic trends common to the swelling of cellulose fibers.

Extent of Swelling

The earliest data on the microscopical measurement of fiber swelling are found in a textbook by von Höhnel [17] published in 1905. He reported the swelling in water as "change in thickness" measured microscopically as the diameter of the cross section for both animal and vegetable fibers. His average figures for plant fibers range from 20 to 30 percent, with cotton 27.5 percent, hemp 22.7 percent, and linen 17 to 29 percent.

Similarly, Haller [16] in 1917 measured with an ocular micrometer the change in ribbon width of cotton fibers and expressed the increase due to swelling as a percentage of the original ribbon width. On 39 fibers immersed in 18.6-percent potassium hydroxide, as compared with 37 fibers of bleached American cotton measured air-dry, he found an average increase in ribbon width of 23 percent. He also reported that air-dried cotton after immersion in water showed an increase in ribbon width of 16 percent, but presumably this is only one result on a single fiber. A similar fiber, air-dried, then desiccated over sulfuric acid for 4 days, showed a decrease in ribbon width of 5.5 percent.

In 1922 Willows and Alexander [27], working on fibers of Egyptian sliver scoured by boiling for 1 hour in 8-percent sodium carbonate, measured cross sections of the fibers by microscopical projection at a magnification of 700. The projected image of the fiber was outlined on paper and the tracings cut out. The areas were calculated from the weight per unit area of the sheets from which the sections were cut. Fibers were measured (*a*) dry, (*b*) wetted with water, (*c*) mercerized, (*d*) washed with water, (*e*) dried, (*f*) wetted with water a second time. The increase in cross-sectional area on first wetting out with water was found from a number of experiments to vary from 40 to 42 percent. In caustic, the increase in area of section was 200 percent for a concentration of approximately 13-percent sodium hydroxide and 270 percent for a concentration of approximately 21 percent. It was found that two drawings of the same set of sections gave results which agreed within about 5 percent, but that the results from different sections varied over 100 percent.

The change in fiber length on swelling with caustic soda was measured by Willows, Barratt, and Parker [28] when individual fibers held vertical by the attachment of a 50-mg. weight were immersed in caustic solutions of varying concentrations.

In 1923 and 1924 Collins and Williams [9, 10] compared the swelling of single cotton fibers in solutions of potassium hydroxide with the swelling in sodium hydroxide. A subsequent paper by Collins [11] in 1925 gives similar data for the other three alkali metal hydroxides.

In 1924, Calvert and Harland [5] used the microscopical method for measuring fiber diameter to determine fiber fineness. The fiber was first treated in 21-percent caustic soda "to restore it to something like its original conformation. The hair then assumed a roughly cylindrical form, the convolutions were eliminated, and measurements of its external diameter could then be made without the grave sources of error attached to the usual determinations of ribbon width." Thirty-five cottons were examined and 400 to 600 fibers were measured for each cotton. Statistical constants are appended in the original article.

The following year the work was continued by Calvert and Summers [6], who published an exhaustive paper on the changes in width which take place in the fiber during mercerization without tension. The relation of mercerized to unmercerized fiber width is examined in 38 cottons and the ratio of mercerized to uncollapsed (from the green boll) fiber width is shown to range from 0.77 to 0.89.

The width changes for a single cotton fiber in solutions of sodium hydroxide ranging from 2.5 to 36.7 percent are described and the conclusion is drawn that no additional width change can be obtained by increasing the concentration of the sodium hydroxide above 15.8 percent. The authors found

TABLE I. SWELLING BASED ON MEASUREMENTS OF PROJECTED DIAMETER (Clayton and Peirce [7])

Preparation	Mean Diameter, R.H. % Original measurement	Percentage increase in mean diameter with change in relative humidity to: R.H. 37%	R.H. 51%	R.H. 76%	R.H. 100%	Wet
Soda-boiled	1.49×10^{-3} cm.	4.2	8.0	10.6	12.9	20
Mercerized	1.36×10^{-3} cm.	3.9	5.2	7.1	12.2	17

that in 18-percent sodium hydroxide the fiber becomes approximately elliptical in a few seconds and on further swelling the section rounds off to an ellipse of low eccentricity, the major axis of which is at least 25–30 percent greater than the fiber width of the corresponding collapsed fiber.

Clayton and Peirce [7] in 1929, in order to evaluate the changes in fiber rigidity at various relative humidities, measured the changes in fiber length and fiber diameter at relative humidities of 0, 46, and 100 percent, for 4 soda-boiled and 6 "mercerized" (15-percent sodium hydroxide) cotton fibers.

Each fiber was hung with a torsion pendulum as load in a closed humidified jar and the length was measured with a cathetometer. While the load was 0.0425 gram, the time of elongation was not stated. The changes in fiber length with change from 0 to 46 percent relative humidity were 2.3 percent for soda-boiled and 2.8 percent for mercerized fibers; while the change from 46 to 100 percent relative humidity was 3.3 percent for soda-boiled and 4.6 percent for mercerized fibers. It is probable that even this small change would not occur except for the load of the pendulum.

Swelling in width was measured from camera lucida drawings of projections at 750 magnification. Two independent series were carried out on a total of 13 soda-boiled and 8 mercerized fibers, and the swelling as given below was calculated from the grand mean of several measurements of all fibers within the microscope field at each humidity. The

TABLE II. MEAN PERCENTAGE INCREASES OF DIAMETER BASED ON INDIVIDUAL MEASUREMENTS AT 0% TO 100% R.H. (Clayton and Peirce [7])

	Soda-Boiled	Mercerized
Observer A	13.06 ± 2.49	12.94 ± 1.16
Standard deviation	13.32	4.56
Observer B	18.15 ± 1.99	
Standard deviation	10.67	
Mean of A & B	15.61 ± 1.67	
Standard deviation	12.34	

percentage increase in mean diameter is rather different from the mean percentage increase in diameter, as will be seen in Tables I and II.

The authors point out that there are many inaccuracies in this type of measurement. "The focusing of the irregular, three-dimensional object, rotation and lateral shifting of the fiber elements at varying humidities, the drawing of the outline, and the tracing of it by planimeter all contribute independent variations in the several measurements which are multiplied ten times or so in proportion to the swelling."

In 1930, Collins [12] investigated the swelling of cotton in water vapor. As he states, it might be anticipated that there is a close parallelism between the extent of the dimensional changes and the amount of the absorption. His measurements show this to be so for temperatures ranging from 20° to 100°C.

The cotton fibers were mounted in a plane-faced glass cell and length and diameter changes were measured microscopically, the "diameter" being the mean of ribbon width observations taken every 0.2 mm. along the fiber. However, these fibers were not of raw cotton, but had been treated in 15.2-percent sodium hydroxide "to smooth out the convolutions and other irregularities."

The washed, dried fibers were kept at a relative humidity of 50 percent. In the experiments the relative humidities used were 97, 90, 80, 60, 30, and 0 percent, at 20°C, phosphorus pentoxide being used to desiccate the fiber. The results are given in Table III.

TABLE III. CHANGES IN DIMENSIONS OF MERCERIZED COTTON FIBERS AT DIFFERENT HUMIDITIES, RELATIVE TO DIMENSIONS AT 0% R.H. (MEAN OF 7) (Collins [12])

Relative humidity (%) at 20°C.	Water (100)	97	90	80	60	30	0	30	60	80	90	97	Water (100)
Area change (%)	48.6	33.9	29.7	22.2	15.7	9.3	0	7.1	12.2	17.2	25.0	31.2	43.9
Length change (%)	0.09	0.58	0.46	0.49	0.30	0.15	0	0.23	0.36	0.09	0.76	0.92	1.12

Further observations by Collins [13] in 1930 included the measurement of the extensibility of cotton fibers at various relative humidities.

The material used was Sea Island cotton treated with 15.2-percent caustic soda, washed, and dried. The mean change in area from 0 percent R.H. to 100 percent without a load was approximately 60 percent.

In 1939, Collins [14], in discussing the fundamental principles that govern the shrinkage of cotton goods by washing, quotes from the original data of his 1930 work [12] to show the hysteresis in the swelling of fibers in water. He states that length changes are so small as to be negligible; from ordinary air-dry condition, say 45 percent R.H., to water, the fibers show an extension of less than 1 percent. On the other hand, the increase in diameter is comparatively large; as the relative humidity of the air is increased the diameter increases progressively until a maximum is reached in liquid water itself. From absolute dryness to water there is approximately a 20 percent increase in diameter; and from 45 percent relative humidity to water, about a 14 percent increase. (Collins was using "mercerized cotton," 15.2-percent sodium hydroxide.) The swelling increases greatly as the humidity approaches saturation and is very closely proportional to the amount of water absorbed.

In the absence of sufficient information on the swelling of cotton in water, a consideration of the somewhat similar data on swelling of jute fibers presented in 1939 by Macmillan and Sen [23] may be of interest. Swelling of jute fibers resembles that of cotton in that it shows hysteresis. The percentage diameter on lateral swelling in jute, as determined by microscopical methods, has been indicated to be in the region of 20 to 21 percent. The length, or longitudinal change, upon increase in atmospheric humidity from 30 to 95 percent, has been found to be approximately 0.14 percent.

In a subsequent paper, 1941, Macmillan and Sen [24] give data on increase in jute fiber area, on swelling in water, on 5 sets of 100 observations each. Swelling is shown to decrease from 47 to 32 percent with increase of cross-sectional area. The mean swelling is 40 percent, which is in fair agreement with the value of 45 percent calculated from the specific gravity. A summary of diameter measurements, using an ordinary microscope, shows that swelling diminishes with increase in diameter, and that the decrease is at first rapid and then slow.

TABLE IV. INCREASE IN RIBBON WIDTH FOR 20 DIFFERENT COTTONS WHEN FIBERS ARE TRANSFERRED FROM WATER TO 18% SODIUM HYDROXIDE (Barritt [3])

Sample	Ribbon width in water (microns)	Ribbon width in 18% NaOH (microns)	Increase in ribbon width (%)
1	15.3	17.4	13.7
2	15.7	18.2	15.9
3	16.5	18.6	12.7
4	16.8	19.0	13.1
5	16.9	19.8	17.2
6	17.4	19.4	11.5
7	17.9	20.1	12.3
8	18.2	19.7	8.2
9	18.4	19.6	6.5
10	18.5	19.8	7.0
11	18.7	20.3	8.6
12	19.0	20.2	6.3
13	20.2	21.6	6.9
14	20.8	19.8	−4.8
15	21.0	21.3	1.4
16	21.8	21.5	−1.4
17	22.6	22.6	0.0
18	22.6	22.1	−2.2
19	25.7	25.8	0.4
20	26.8	26.1	−2.6

The authors state that a similar relationship between fiber width and swelling has been found for cotton by Küsebauch, but the original data given by Küsebauch [22] would seem to support this conclusion only in part. Moreover, Küsebauch used strong solution of caustic soda and ammonia rather than distilled water.

Barritt [3], on the other hand, gives a table of measurements for 20 different strains of cotton which appears to confirm the observations on jute. (See Table IV.) The increase in ribbon width on swelling the cell wall with caustic soda varies inversely as the diameter of the uncollapsed fiber; when the diameter exceeds 20.8 microns there is no increase in ribbon width, but rather, at times, an apparent decrease.

Barritt points out that the unexpected decrease in diameter of the coarser fibers may be accounted for by a change in shape of the cross section from an ellipse to a circle.

Pretreatment of Materials

Haller [16] and von Höhnel [17] are the only authors who report on microscopical measurements of the swelling of raw cotton in water. The fibers used in the experiments of Willows and Alexander [27] were scoured by boiling in 2-percent sodium

carbonate; the fibers used in the work of Collins and Williams [9, 10] and Collins [11] had been pretreated in 15.2-percent sodium hydroxide; and those of Calvert and Harland [5] in 21-percent sodium hydroxide.

While the object of the caustic pretreatment is to remove the irregularities peculiar to the dried and collapsed fiber, and thus to minimize the inaccuracies of microscopical measurement, the effect of this mercerization upon the properties of the fibers is not to be ignored. Clibbens [8] in 1923 published an excellent description of the microscopical characteristics of cotton which had been mercerized in the loose state.

Coward and Spencer [15] in 1923, while measuring the absorption of caustic soda solutions by cotton, came to the conclusion that the dried fiber absorbs the solution until it assumes the same diameter that it had as a living cell inside the boll and that the limit of swelling, which is nearly three times the original volume, is reached at about 14.3-percent sodium hydroxide; no further swelling occurs in stronger alkali. It was concluded that the cuticle of the fiber is responsible for this limitation, since the contents of the fiber are capable of much greater swelling when unconstrained by cuticle.

This conclusion was supported by work of Calvert and Summers [6], who in an investigation of transverse sections of collapsed fibers during mercerization and of uncollapsed fibers from the boll, before and after treatment with sodium hydroxide, found that the maximum width change has occurred when the swollen fiber attains the width it possessed in the boll before collapse. It is shown again that this maximum is due to the presence of the cuticle of the fiber, which sets a limit to the amount of swelling in the outward direction. They found that maximum swelling in the sodium hydroxide occurs at a concentration of 13.5 percent. Barritt [3] in 1929 confirmed the idea that the cuticle determines the final diameter of the swollen cell wall of all types of cotton; and Moore [25] in 1938, upon measuring the diameter of uncollapsed fibers from the green boll and mercerized fibers in seven strains of American upland cotton, found the correlation between uncollapsed and mercerized fiber diameter to be 0.95.

Calvert [4], in studying the length changes of cotton hairs in solutions of caustic soda, measured the width changes of raw, scoured, and mechanically rubbed fibers in air and in various concentrations of caustic soda. These measurements showed that increase of width of scoured and of rubbed fibers is greater in caustic soda solutions than that of raw untreated fibers. There is every indication from these data that the behavior of the fiber is influenced by mechanical treatment—apparently by the removal to a greater or less degree of some restriction to swelling which is presumed to be the fiber cuticle.

Statistical Evaluation of Results

In 1922 Thomas Barratt [1] made measurements of length, ribbon width, breaking stress, and extension at break of single cotton fibers from two kinds of Egyptian cotton. In order to obtain good average results 400 fibers were selected at random from each sample of about half a pound of sliver, and 100 of these were employed in the examination of each of the four properties mentioned. Lengths and diameters were measured by microscopic projection at magnifications of 16 and 880, respectively. The representation of these experimental results in the form of curves and their comparison with the "probability curve" brings out clearly certain important points which might easily be overlooked from consideration of the numerical figures alone. Barratt concluded that cotton fiber width follows the curve of normal distribution.

Calvert and Summers [6], in commenting on the lack of statistical analysis in early works on swelling, stated that the question of obtaining from a seed that may possess as many as 8,000 fibers, or from the bale that contains literally billions, a sample of fibers truly representative of the whole population is of fundamental importance to any investigation of dimensional change in the fiber.

Willows, Barratt, and Parker [28], studying the length changes of single fibers of scoured Egyptian cotton in different concentrations of sodium hydroxide, tested about 12 fibers in one set of experiments and 20 in another to obtain one point on their curves, while in a third set for each point on the curve "50 to 200 observations were made and their mean taken."

Willows and Alexander [27] in their investigations used "some hundreds of fibers" to fix one point on the curve of results while Collins and Williams [9] presented curves and tables of results obtained from "the mean of the observations on the *only five hairs* which survived the whole series of solutions." The same authors [10], in an extension of the work, employed the values of changes given by 7 raw and 5 water- and soda-boiled fibers.

TABLE V. CONSTANTS MEASURING DISPERSION OR DEGREE OF VARIATION IN LENGTH AND WIDTH (Koshal and Turner [20])

	Mean	Standard deviation	Coefficient of variation
Fiber length (cm.)	2.33	0.491	21.0
Fiber width (10^{-5} cm.)	179.88	19.92	11.05

When Calvert and Summers [6] experienced difficulty in comparing the results of these previous workers they determined to take into account the large dimensional variations found among the fibers of any sample of cotton and the large mean variation in the same respect between one type and another. Measurements were made on 250 fibers for each sample and standard deviation and the probable error was calculated in every set of measurements.

In 1930 and 1931 Koshal and Turner [20, 21] undertook the determination of the number of cotton fibers which constitutes a satisfactory sample for determining the various fiber properties such as length, width, strength, and rigidity, and what degree of reliability might be expected in the tests of such fiber properties. For width and convolutions the fibers were mounted dry on a glass slide and the ends fastened down. During mounting, sufficient tension was applied to straighten the fiber. Each fiber was numbered; its width was determined by measurement under the microscope at ten different places along the fiber.

The frequency distribution obtained for width on 3,000 fibers does not depart much from the normal curve and it is concluded that the fiber width distribution can be assigned to the normal curve without appreciable error. Table V shows the values of different measures of variability for the several fiber properties based on measurements of 3,000 hairs.

In the case of fiber length and width, which give nearly symmetrical frequency distributions, the mean value and the probable error of a single observation are sufficient to indicate the composition of a sample. The degree of reliability of small samples is indicated in Table VI, which shows the total range in which the mean of a random sample of a given size will lie, with odds of 20:1.

In the selection of a certain-size sample as representative, the authors were guided partly by the degree of reliability of the result for that size and also by practical consideration of the difficulties of making a very large number of tests. Bearing both these points in mind they considered that a minimum of 500 tests should be made to determine fiber length and a minimum of 300 for fiber width.

TABLE VI. RANGE (% OF MEAN) FOR WHICH THE ODDS ARE 20:1 THAT IT WILL CONTAIN THE MEAN OF A RANDOM SAMPLE OF FIBER LENGTH OR RIBBON WIDTH OF THE SIZE SHOWN (Koshal and Turner [20])

Fiber property	Number of fibers				
	200	300	400	500	600
Fiber length (cm.)	18	16	13	11	9
Fiber width (10^{-5} cm.)	5	2.7	2	—	—

In 1931 Pope [26] published a paper on the determination of sample size for diameter measurements in cotton fiber studies. He states that although the measurement of the width of mercerized cotton fibers should be more significant than ribbon width measurements of raw fibers owing to the regularity induced by mercerization, the swollen condition of the fiber is not the normal condition in which fibers occur in spinning operations. For this reason he describes a method of measuring collapsed dried fibers based on the work of Barritt [2], who devised the formula $\frac{W+T}{2}$ for approximating cotton fiber diameters. The width W is the measurement taken at the widest part of the convolution as it appears in flat view. The thickness T is the measurement of the edge-on position of the fiber. These two measurements were taken on consecutive twists of the convolution in order to eliminate any errors due to differential development along the fiber profile.

The fibers were kept moistened with gentian violet solution on a microscope slide in order to render the focal point more distinct. With the fiber micrometer two measurements were made on each slide. Consecutive measurements of width and thickness were made along a considerable number of fibers as a preliminary profile test in order to determine the region in which the sample measurements should be taken. These measurements indicated that there is relatively little variation within, roughly, the central half of the fiber length.

From the two measurements made on the fibers, two constants were calculated: (*a*) the mean ribbon width or mean diameter $\frac{W+T}{2}$ suggested by Barritt [2], and (*b*) the dimension ratio W/T. The mean diameter measurement was proposed by Barritt in order to minimize the influence of underde-

veloped fibers on the mean measurement, which is closely equivalent to the diameter of the turgid fiber. The dimension ratio is suggested as a means of bringing out differences in wall thickness between varieties having a comparable mean diameter as well as a measure of the variation in wall thickness within the variety. A dimension ratio approaching 1.0, if it were ever obtained, would mean no collapse of the fiber wall and consequently no convolutions; and, conversely, the larger the ratio the thinner the fiber wall. An extremely high ratio indicates immaturity and a comparison of the ratios for a number of strains gives a relative measure of the thickness of the fiber walls.

The evidence obtained from this experiment indicates that a sample size of 100 measurements of width and thickness will provide a safe margin of statistical significance for determination of differences on the basis of a 0.5 micron range as well as a range of 2.5 percent of the mean.

In 1939 Koshal and Ahmad [19] reported work on the determination of the diameter of mercerized cotton fibers. Their method was as follows:

The fibers were spread out on a slide and carefully separated by means of a blunt needle. They were irrigated with 18-percent caustic soda solution which caused the fibers to swell and cross sections to assume a more nearly circular form. One reading near the middle of each fiber was taken on a micrometer scale in the eyepiece of a microscope. As a result of this investigation the authors recommend the following procedure for the accurate determination of this property [19]:

1. Swollen diameter measurements should be carried out by two testers.

2. Each tester should prepare a slide and take swollen diameter measurements on 75 fibers for cottons in general and on 100 fibers for special cottons.

3. The mean results obtained by the two testers for the same cotton should not vary by more than 6 percent for special cottons and 7 percent for other cottons. If larger differences occur, tests should be repeated by one or both testers.

4. The extreme variation for $P = 0.05$ * which may be expected between two cottons due to random causes is about 5 percent for mean values based on 150 tests and about 4 percent for those based on 200 tests. If larger differences are observed these may be due to specific treatment effects.

* Odds = 20 : 1.

Summary

The literature on the microscopical measurement of cotton contains little useful information on the swelling of fibers. There is virtually no work reported on the microscopical measurement of raw cotton fibers swelled in water. The majority of studies were made on fibers that had been either mercerized or purified by boiling in sodium carbonate, and much of the work had to do with the swelling of dry fibers upon immersion in a solution of one of the alkali metal hydroxides. It is difficult to compare results of one worker with those of another because of the variations in pretreatment of the fibers. The earlier works of Haller [16], von Höhnel [17], Willows, Barratt, and Parker [28], Clayton and Peirce [7], and Collins and Williams [9] are invalidated by the fact that their conclusions are based on less than two dozen fibers in each experiment. The statistical work of Pope [26] and of Koshal and coworkers [19–21] indicates that adequate sampling is not achieved with fewer than 100 fibers in any given case. While estimation of the change in area of the cross section calculated from the ribbon width of the fiber has been accepted as a measure of swelling, it would seem that the degree of circularity, or ratio of width to thickness, as measured by Barritt [2] and by Pope [26], is a better index of the amount of change induced by absorption of water, since it indicates the extent to which the fiber has returned toward its original shape in the living boll.

Inasmuch as there is so little information on the effect of water on the swelling of cotton, a valuable contribution would be made by work offering data on such questions as the following:

1. Are the varietal differences in commercial cottons evident in the swelling of their fibers in water?

2. Is the swelling of "flat-fibered" types of fibers of the same order as that of "round-fibered" types?

3. In the same sample of cotton, what degree of difference exists in the swelling of mature and immature fibers?

4. Is the swelling merely a change in circularity dependent upon unfolding of wrinkled areas of the cell wall, or is there an actual increase in cell-wall thickness?

5. Is an increase in cell-wall thickness accompanied by change in lumen size?

6. How is increase in cell-wall thickness related to differences in cell shape, fineness, or maturity?

In view of the absence of such data it is evident that continued work on the microscopical measurement of single fibers is amply justified.

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Apparatus for Determining the Coefficient of Friction of Running Yarn*

Francis Breazeale†

THE determination of the coefficient of friction of yarn running over various materials is of acknowledged importance from numerous standpoints. Among these may be listed the evaluation of various finishes as yarn lubricators, and the design of guides and tension devices to give specified tension changes in a running thread.

Accordingly, an apparatus to study this coefficient was constructed which, with certain auxiliary equipment, allows the coefficient of friction of yarn against various materials to be read directly from a scale. A feature of the design of this instrument is that the tension in the yarn, or the speed of yarn travel, does not influence the indicated value except in those cases in which these variables actually change the value of the coefficient of friction itself. Strictly speaking, this is true only when the frictional forces in the moving parts of the apparatus are zero; however, with proper attention given to all bearings a good approximation to this condition is realized.

General Assembly of Apparatus

A functional view of the assembly used is shown in Figure 1. The yarn is pulled off the yarn package and fed through a tension device whereby the desired tension is introduced; that is, the tension under which the coefficient of friction is to be determined. The tension device may consist of a smooth grooved roller, around which the thread is wound several times, and against the side of which a felt, spring-loaded brake is held. Adjustment of the spring load thus controls the tension in the thread leaving the device. The thread then passes to a tensiometer, to be described, which instrument feeds voltage proportional to the thread tension into a Leeds and Northrup potentiometer-type circular chart recorder. The spring on the tension device may be adjusted until the recorder indicates that the tension desired obtains. From the tensiometer the yarn is fed through the coefficient-of-friction indicator proper, also to be described, at which point this coefficient is read. Finally, the thread is taken up by a reel, hand or motor drive, as desired.

Coefficient-of-Friction Indicator

The physical principles employed in the coefficient-of-friction indicator proper are shown in Figure 2.

The first is the classical "belt drive" formula, which relates the ratio of the tension of a belt (or thread) before (T_2) and after (T_1) passing over a loaded or, as in our case, a stationary circular surface (shown by the cross-hatched circle). Here

$$\frac{T_1}{T_2} = e^{\alpha k}, \qquad (1)$$

where: T_1 = tension in thread after passing over surface;

T_2 = tension in thread before passing over surface;

e = base of natural logarithms;

α = angle, in radians, of thread contact (in our case, π);

k = coefficient of friction of yarn against material in question.

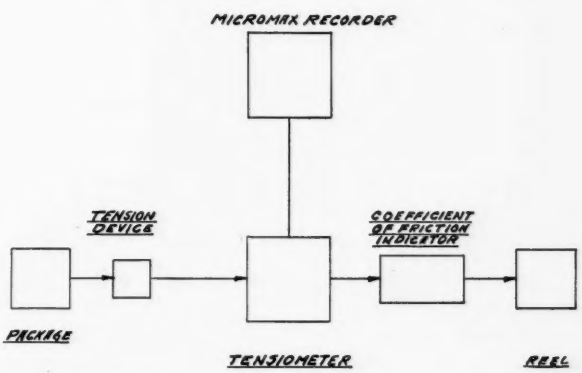

FIG. 1. *Functional diagram of assembly of the apparatus described.*

* Presented at the Joint Meeting of the Fiber Society and the High Polymer Physics Section of the American Physical Society at Charlottesville, Virginia, September, 1946.

† Research Department, American Enka Corporation, Enka, North Carolina.

Rewriting equation (1):

$$k = \frac{\ln T_1/T_2}{\alpha}. \qquad (2)$$

The second principle concerns the equilibrium position of the right-angle lever system shown in the top of Figure 2. If the pulleys at the ends of the equal-length lever arms are frictionless, and the thread, both coming on and leaving the pulleys, is held parallel to the dotted line shown, it can readily be demonstrated that:

$$\frac{T_1}{T_2} = \tan \beta. \qquad (3)$$

Combining equations (2) and (3), we may then write:

$$k = \frac{\ln \tan \beta}{\pi} \qquad (4)$$

for π radians of thread contact.

The fashion by which these principles are translated instrumentally is shown in Figure 3, which is a schematic picture of the actual instrument. The left-hand portion of the figure will be recognized as the system shown at the bottom of Figure 2; whereas the "basic lever system," shown at the right of Figure 3, corresponds to the right-angle lever arrangement shown at the top of Figure 2. The sole purpose of the two independent levers, their connecting chains, and the connecting rods, is to transmit the tensions T_1 and T_2, in the pulleys A and B, to the basic lever system. The two levers on which the pulleys A and B are fixed are balanced so that with the chains hanging free the levers remain in a horizontal plane when there is no yarn in the apparatus. Thus, no gravity component is brought to bear on the basic lever system. The rotation of the latter system is observed by a pointer, which is adjusted to read 0 when $\beta = 45°$.

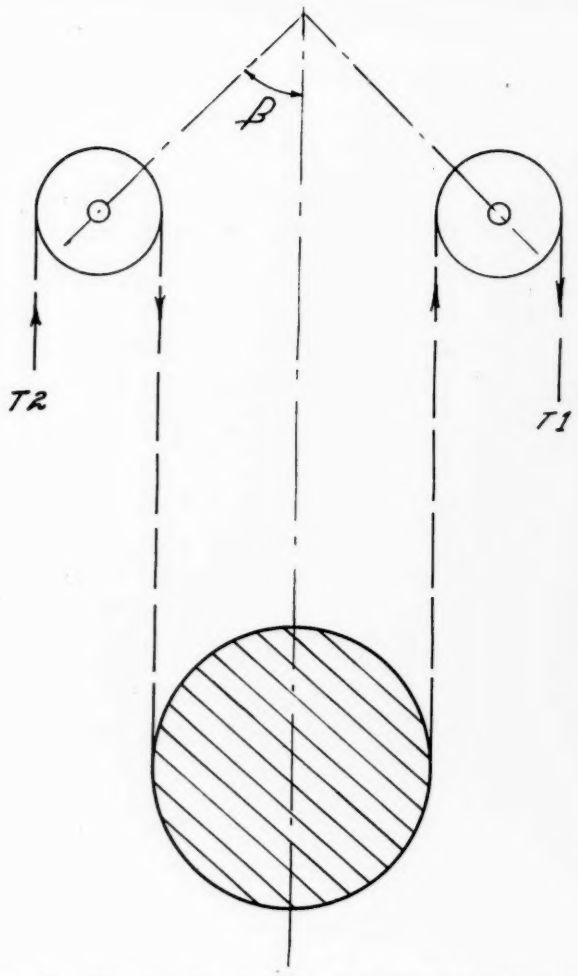

FIG. 2. *Showing the physical principles employed in the coefficient-of-friction indicator.*

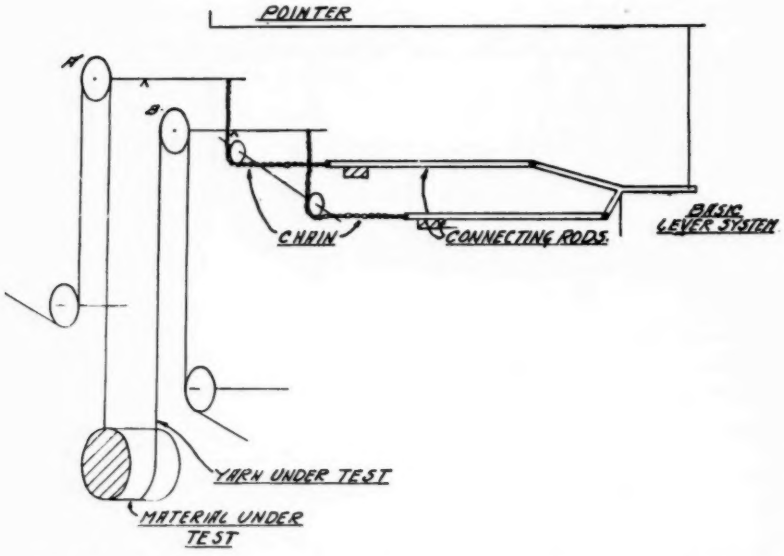

FIG. 3. *Schematic diagram of the coefficient-of-friction indicator.*

The instrument, threaded up, is seen in Figure 4. The material under test, held in a clamp, is shown at C. The wheels directly above the specimen are mounted on rotatable members which are adjusted so that thread contact on the specimen is al-

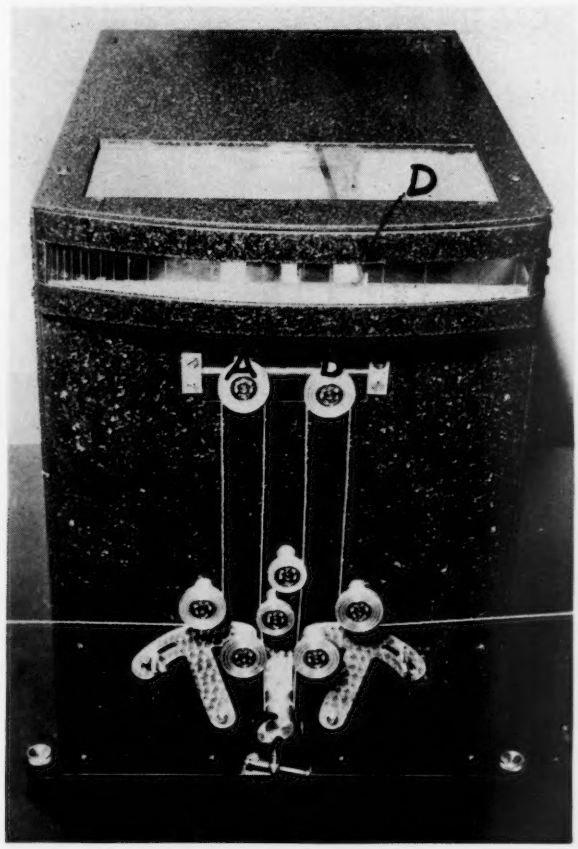

FIG. 4. *Front view of the coefficient-of-friction indicator.*

ways 180°. This arrangement allows rods or cylinders of various diameters to be tested. The other four pulleys at the bottom of the instrument serve to keep the thread sections going to and from the two top lever pulleys A and B parallel at all times. The pointer, D, is seen behind the lucite scale, which is graduated in coefficients of friction from 0 to 1, in steps of 0.05.

The scale marking is determined by hanging weights on the two pulleys A and B in various ratios, corresponding to values of k from 0 to 1.0, in intervals of 0.05. It is most convenient for this purpose to plot T_1/T_2 as a function of k for $\alpha = \pi$, using equation (1). This curve is shown in Figure 5. A scale made this way will closely match one made by using equation (4) and plotting β as a function of k, but the former method is to be preferred since certain ideal conditions (which equation (4) demands) are not found in the actual instrument, the chief one being the absence of absolute parallelism of the connecting rods for all angles of basic lever deflection.

The friction in the moving elements of this instrument is sufficiently low so that the absolute magnitude of the weights used to obtain a certain weight ratio does not significantly affect the pointer position provided the smaller of the two weights is greater than several grams.

Tensiometer

Before discussing the tensiometer which has been used in this assembly it should be stated that a less refined, mechanically indicating tensiometer would probably serve the present purpose nearly as well, if a record of the tension is not particularly desired.

The instrument, with cylindrical lucite cover removed, is shown in Figure 6. The path of the thread is shown by dotted lines; it will be seen that it runs over two agate bearing pulleys and is drawn up between them to run over a third one, A, mounted on a counterweighted lever, A' (the counterweight serves only to balance the pulley). The movement of this lever arm is transmitted through a shaft, B, to a gear, C, and is opposed in torque by a length of wire, D, positioned between clamp E (free to turn) and clamp E' (stationary). Fine adjustment of tension ranges may be made by loosening the two screws in E', sliding this member along the bar

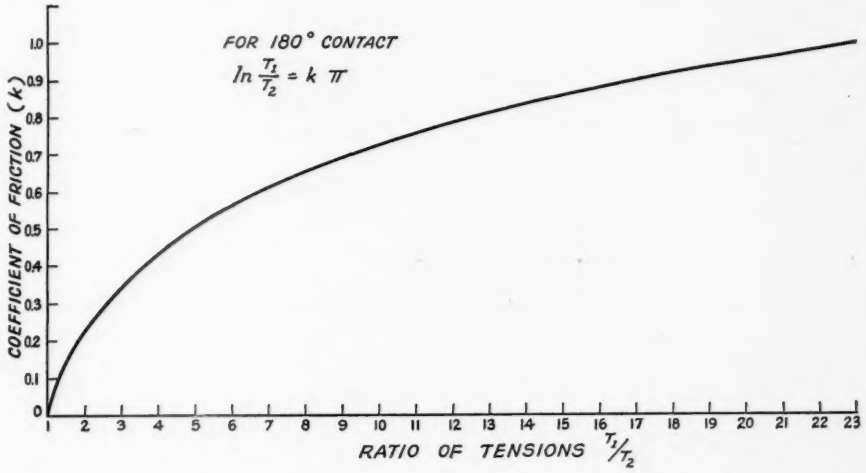

FIG. 5. T_1/T_2 *as a function of coefficient of friction for 180° of thread contact.*

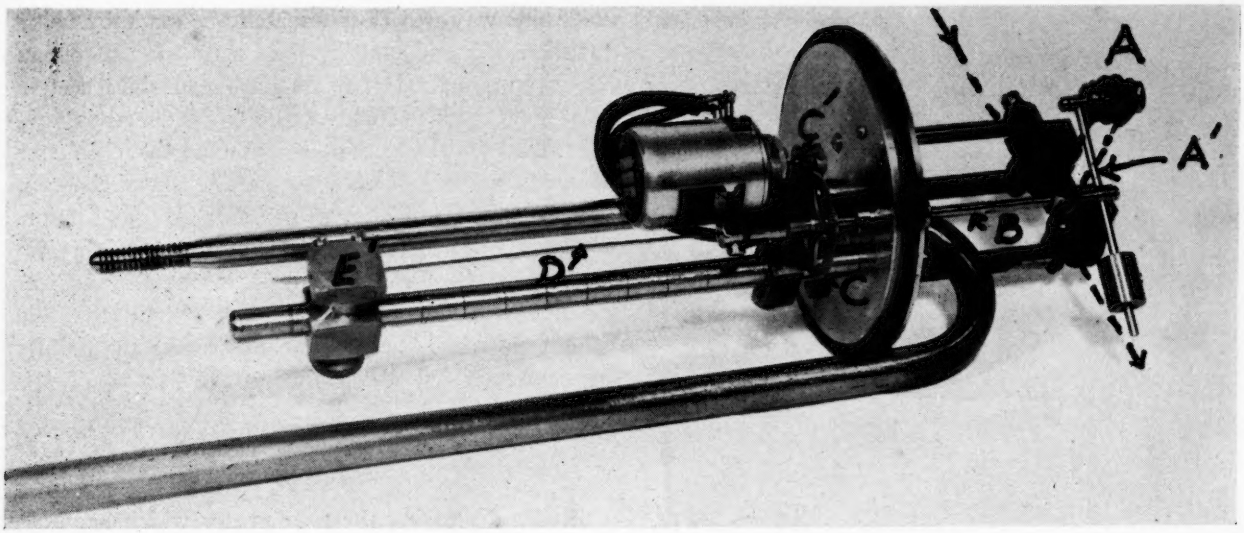

FIG. 6. *General view of the tensiometer, with lucite cover removed.*

until the desired length of torsion wire is obtained and then retightening the two screws and the knurled nut, shown. For gross changes in tension range, wires of various diameters are employed. Returning to the gear wheel, *C*, it will be seen that this is meshed with a smaller gear, *C'*, which is fastened to the shaft of a "Microtorque Potentiometer." * The ratio of the number of teeth in these gears is approximately 3 : 1, thus giving an angular deflection magnification of this amount. With a constant voltage (from "A" batteries in series) fed into the potentiometer, the output voltage will vary with the angular deflection of the pulley arm, *A'*, which, in turn, is positioned in nearly linear rela-

* This particular model has a resistance of 1,000 ohms and is rotatable through 270°.

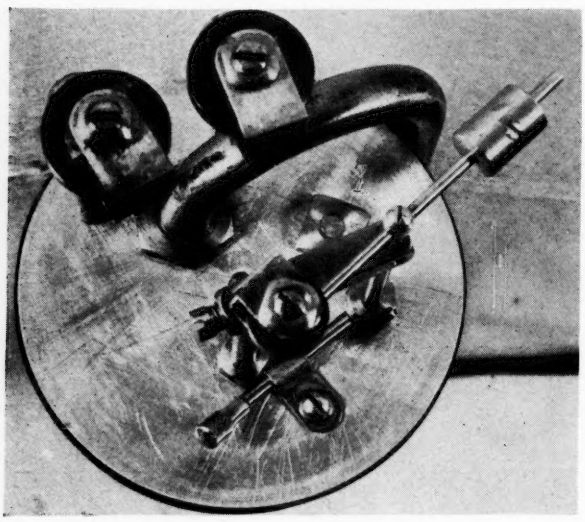

FIG. 7. *"Business end" view of the tensiometer.*

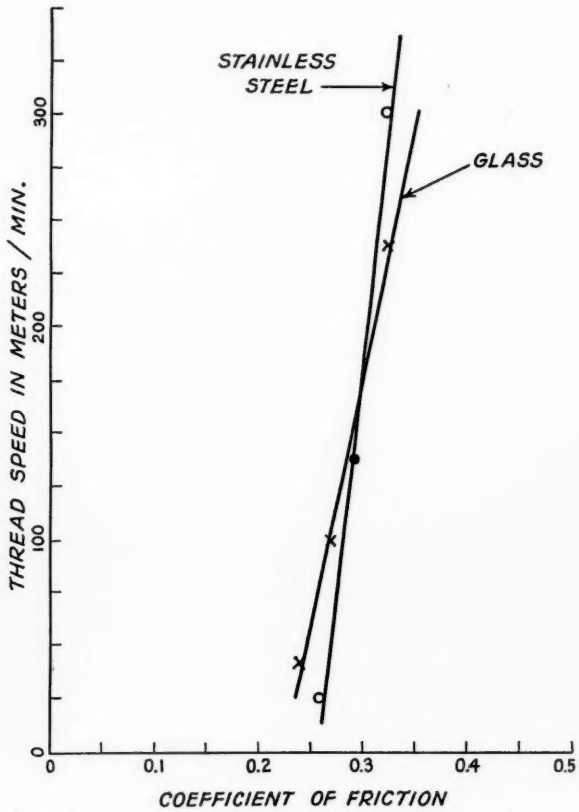

FIG. 8. *Showing coefficient of friction versus yarn speed, for glass and stainless steel, at a pre-tension of 40 grams.*

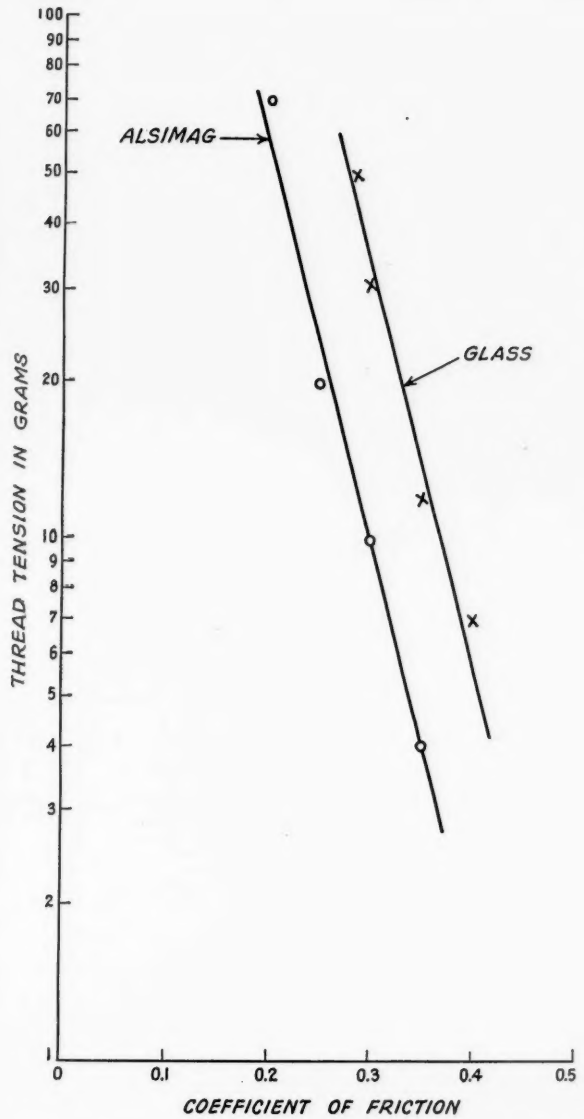

FIG. 9. *Showing coefficient of friction versus tension of yarn, for glass and "Alsimag" at a speed of 100 meters per minute.*

tionship with the thread tension. The wires feeding into and from the potentiometer are enclosed in a steel tube, the piece nearest the observer, in Figure 6. The cylindrical lucite cover is held by a circular disc of equal diameter, which fits over the threaded end of the supporting rod (at left in Figure 6), and which is secured in place by a wing nut. To this disc is welded a short metal rod for purposes of clamping the whole unit for use. Figure 7 shows the "business end" of the instrument. The oil gland and filling tube for the shaft, *B* (Figure 6), may be seen.

Calibration of the unit is effected by first supporting it in a horizontal position and turned so that a line connecting the centers of the two guide wheels is vertical. A length of yarn is then clamped directly above the outside flange of the top guide wheel, and threaded through in the normal manner. Various weights are attached to this yarn and the deflection of the recorder noted in each instance, thus giving a tension-deflection calibration. In place of a recorder, a conventional millivolt meter could be used.

Typical Results

Some typical results which have been obtained with the assembly discussed are presented in Figures 8 and 9. A lubricated, 1100/480 tire yarn was used throughout. Figure 8 shows the increase in coefficient of friction with increase in thread speed, at a constant pre-tension of 40 grams, against smooth glass and stainless steel. The explanation for the change in coefficient does not suggest itself. Figure 9 demonstrates the linear relationship between coefficient of friction and the logarithm of the tension in the thread, at a constant speed of 100 meters per minute, for glass and "Alsimag." The reason for the decrease of this coefficient with increased normal pressure of the yarn against the material under test is also not known.

Acknowledgment

The coefficient of friction indicator was constructed by Mr. Owen Morgan, and the tensiometer by Mr. Boone Williamson, both of the Enka Instrument Shop.*

Thanks are due Dr. A. J. L. Moritz, Technical Vice-President of the American Enka Corporation, for permission to publish this paper.

* A number of general-arrangement blueprints of these two instruments are available, on request, to interested persons.

Use of Supersonics in the Preparation of Fiber Samples for Electron-Microscope Studies

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Pflanzenphysiologisches Institut, Zürich, Switzerland

In response to a request by TEXTILE RESEARCH JOURNAL *for a brief report of the use of supersonics in the preparation of fiber samples for studies with the electron microscope at the Institute of Plant Physiology, Zürich, Switzerland, Dr. Frey-Wyssling, Director of the Institute, submitted this paper for publication.*

It will be noted that the photographs show the typical fibrillation of fibers similar to that obtained in a ball mill except that they are much clearer. There is less debris attached to the fine strands which seem to have been separated into finer and finer units as described by the authors. If these photomicrographs are studied under a magnifying glass considerable detail can be observed.

IN an attempt to prepare fiber samples for observation under the electron microscope, supersonic waves were used to disintegrate them. This method appears to afford better preparation than does the ball mill.

A nickel-steel vibrator designed by Biennophone, Bienne (Switzerland), was used [1]. The fibers, in the form of a twisted bundle held under slight tension, were immersed in water and exposed at a distance of 3–5 mm. from the vibrator surface to supersonics of 10,000 Hertz during an exposure of 3–5 minutes.

It was observed that this treatment applied to ramie, flax, hemp, and cotton results in a disintegration of the fibers into fibrils. These fibrils, however, do not have uniform diameter; under the optical microscope they taper at the ends into invisible microfibrils, this tapering being best shown by the phase-contrast microscope (Figure 1A).

The electron microscope [2] reveals a microfibrillar structure (0.1 μ in Figure 2B) in which the fibrils appear to be further split into finer and finer strands the smallest of which measure 60 Å. in diameter. These may be termed micellar strands because they have the same diameter as the crystallized cellulose strands reported by x-ray analysis [3]. The micellar strands are composed of about 100 cellulose chain molecules. It is interesting to conjecture that there may exist still finer strands, composed of only a few chain molecules, invisible even under the electron microscope.

We might, therefore, conclude that there is no definite unit particle or element of uniform size between the cellulose chain molecule as a chemical unit and the fiber cell as a cytological unit. Fibrils, microfibrils, and micellar strands are not natural units in the cell wall but disintegration products of the plant fiber.

The sizes of the fibrils, the microfibrils, or even the micellar strands are dependent upon the method of disintegration of the coherent fiber texture. This conception of the fiber as a coherent micellar system was proposed in 1935 [4], and later repeatedly defended [5]. Its correctness has now been proved by the studies using a combination of supersonic waves and the electron microscope.

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† *Dipl. rer. nat.* [Diploma in Natural Science], Swiss Federate Institute of Technology, Zürich, Switzerland.

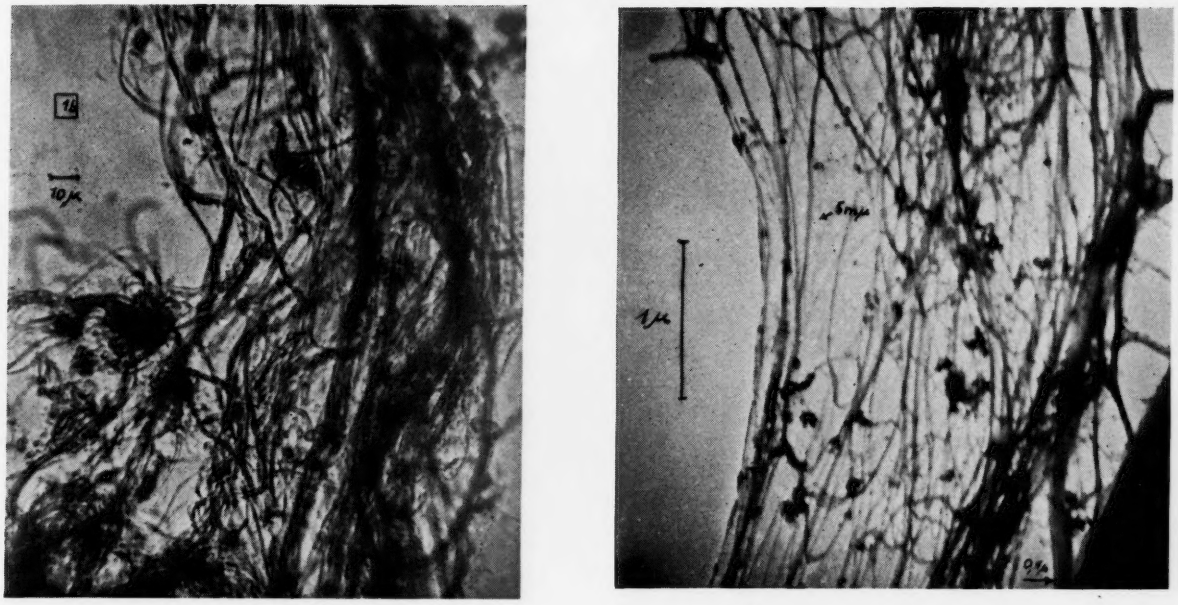

FIG. 1. *Fibers disintegrated with supersonics. A (left)—Photomicrograph from ramie fibers; magnification, 400 ×. The rectangle represents an area equal to that of Figure 1B. B (right)—Electron picture of hemp fibers; magnification, 20,000 ×. Photograph obtained from ordinary preparation mounted on zapon lac film.*

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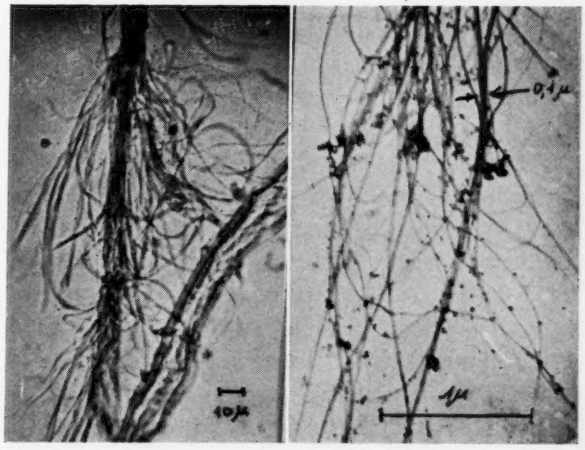

FIG. 2. *Fibers disintegrated with supersonics. A (left)—Photomicrograph of fragmented cotton fibers; magnification, 400 ×. B (right)—Electron picture of hemp fibers; magnification, 20,000 ×.*

Discussion of Published Papers

"Cellulose Behavior with Filtered Light from a Carbon Arc Source"*

Comments by Dr. E. I. Stearns†

In this department from time to time are published discussions of papers which have appeared in previous issues of this publication. These are presented in the belief that such discussion will result in bringing out additional information with respect to a given subject. The JOURNAL *welcomes comments concerning papers which it publishes. When possible, additional data from the correspondent's research should be incorporated. The editors of course reserve the right to decide whether comments will or will not be published in this department.*

IN the September, 1946, issue of TEXTILE RESEARCH JOURNAL I note an article entitled "Cellulose Behavior with Filtered Light from a Carbon Arc Source," by K. S. Campbell and P. J. Fynn. In Figure 1 of this paper there are presented transmission data in the range 1200 to 2000 millimicrons obtained with a Beckman spectrophotometer. Our experience with this instrument indicates that there is considerable stray light in this wave-length range, as can be observed by removing the photocell and transmission chamber unit and looking into the monochromator. This stray light will cause a galvanometer deflection, and in operation the instrument will behave as if a legitimate transmittance measurement were being made. However, the photocell normally supplied with the Beckman spectrophotometer is not sensitive to radiations of longer wave-length than 1200 millimicrons. It therefore seems to the casual reader of this article as though false transmittance data had been plotted in Figure 1 of this article over this wave-length range because of a lack of appreciation of photocell sensitivity and stray light effects.

If by any chance the Beckman spectrophotometer had been modified by using a suitable photocell and by eliminating the stray light as might conceivably be done by use of a suitable filter, this would be a most interesting development and should certainly be described in some detail.

[If any of our readers have developed a modification of the Beckman instrument such as is suggested by Dr. Stearns we would appreciate being apprised of such development. We would welcome the opportunity of bringing it to general attention through the pages of this JOURNAL.—*Editor*]

Authors' Comments

The wave length-% transmission curves presented in Figure 1 of the paper "Cellulose Behavior with Filtered Light from a Carbon Arc Source" were determined with a Beckman spectrophotometer without employing any special accessories or techniques. It is admitted that the results obtained for wave lengths greater than 1200 millimicrons are lacking in precision owing to the increasing loss of sensitivity of the instrument and the fact that the values for the points on the curves above 1200 millimicrons are not strictly comparable with those below 1200 millimicrons. Still, the curves obtained beyond 1200 millimicrons are indicative of how the filters transmit radiation of wave lengths 1200 to 2000 millimicrons even if not to the same degree of exactness as in the case of the shorter wave lengths. The photocell does respond to light transmitted by filters in this region and it is difficult to see how the stray light which is known to be present can produce a demonstrable maximum in the disputed region for one filter, a descending curve for another filter, an ascending curve for a third, and a high plateau for a fourth. The curves were drawn beyond the 1200 millimicron limit of strict accuracy to convey a usable conception of the relative transmissions of the filters in this longer wave-length region.

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* Title of a paper by K. S. Campbell and P. J. Fynn, which appeared in the September, 1946, issue of TEXTILE RESEARCH JOURNAL.

† Assistant Director, Physics Research, Calco Chemical Division, American Cyanamid Company, Bound Brook, New Jersey.

Book Reviews

America's Fabrics. Zelma Bendure and Gladys Pfeiffer. New York, Macmillan Company, 1946. 688 pp. Price, $10.00.

(*Reviewed by Vittoria Rosatto*)

In one volume, clearly explained and lavishly illustrated, Zelma Bendure and Gladys Pfeiffer tell the story of the many consumer fabrics manufactured in this country today. The authors, aided by authorities in the many branches of fabric manufacture, bring to those who work with fabrics an intelligent presentation of clothing, rugs, laces, and home fabrics from the fiber to the finished product.

The simply stated, essential technical information, including a chapter on chemistry, provides a common basis of understanding, whether the reader is a consumer, a student, or a manufacturer; whether selling, distributing, or advertising.

The book contains 22 chapters, 8 of which are devoted to the many fibers, their sources, history, and processing, and include: wool, hair, silk, cotton, flax, hemp, jute, ramie, sisal, coir, asbestos, rayon, nylon, Vinyon, Saran, casein, soybean, glass, and others.

A chapter on yarns presents the different processes of yarn spinning, explains twisting, and includes in the illustrations single, ply, core, chenille, and novelty yarns magnified to bring out characteristics which influence and contribute to the appeal of the final fabric. The preparation of the yarns for further processing on the different machines which construct the fabric is adequately explained.

The construction of fabrics is treated by chapters covering weaving, knitting, lace-making, and felting. The dyeing, printing, and finishing information further guides the reader to the ultimate fabric. Included in the illustrations are photographs which show principal steps in all phases of manufacture and photographic studies of representative fabrics to convey texture and pattern.

A chapter on fabric names, descriptions, and end-uses, together with a chapter on testing and standards, rounds out this most interesting and informative survey.

The Alkaline-Earth and Heavy-Metal Soaps. Stanley B. Elliott. 342 pp. + x. New York, Reinhold Publishing Corp., 1946. Price, $7.50.

(*Reviewed by Earl K. Fischer*)

This volume, No. 102 in the American Chemical Society monograph series, is a welcome addition to the literature, for it is one of the few compilations of data and uses on the alkaline-earth and heavy-metal soaps. Because of the scattered nature of the information and the difficulty in finding a natural order for the topics covered, the author has adopted a simple but somewhat arbitrary classification. Nine chapters (111 pages) are devoted to a general discussion on properties, raw materials, manufacturing methods, solvents, and applications. Another group of 8 chapters (102 pages) takes up the separate compounds in the sequence of the occurrence of the metals in the periodic table. A final 5-page chapter describes analytical methods. Miscellaneous information is collected in 6 appendices.

Emphasis throughout is on the commercial applications of these soaps. Theories are only occasionally, and then briefly, noted. The result is an amassing of factual material which is easily read but which will probably prove most useful for reference purposes. The book is not an exhaustive survey, for numerous omissions, to both the patent and technical literature, will be observed by any person who has worked in the fields covered. On the other hand, the author has noted many gaps in available information on these compounds, and he has in this way performed a useful service by pointing out fields for research.

Economics of the Cotton Textile Industry. Jules Backman and M. R. Gainsbrugh. New York, National Industrial Conference Board, 1946. 207 pp. Price, $1.50.

(*Reviewed by Robert B. Evans*)

This publication is the first of a series of industry base books to be published by the National Industrial Conference Board with the object of providing an annual or periodic handbook on each of the na-

tion's major industries. "Each of these industry almanacs will present facts as to wages and hours, profits, taxes, investment, prices, employment, productivity, and related economic measures of past development and current trends." Costs of preparation and publication of this particular volume were met by the American Cotton Manufacturers' Association. It was released in preliminary form for the use of this group.

In the first chapter, the importance of the cotton textile industry in the nation's economy is discussed statistically from the viewpoint of the value of its products and the employment it gives. The large number of units in each branch of the industry and its highly competitive nature are noted. Then there is a discussion of the industry's capacity to produce textiles, the relationship in the industry between size of inventories and profitable operation, and the recent trend toward integration. The declining trend in per capita use of cotton goods prior to the war and the upsurge in use of rayon are noted. A very comprehensive chapter on wages and employment is another feature of the volume. It is stated that productivity in the industry increased 76% between 1921 and 1939, but that it remained virtually unchanged during World War II while wages were climbing from an average of 32.4¢ an hour in August, 1939, to 72.4¢ per hour in January, 1946. Wages and the cost of living in the South are discussed and compared with conditions elsewhere. In a concluding chapter, it is pointed out that only 12¢ per sales dollar was available in the industry in 1940 to meet selling, administrative, and overhead costs, taxes, and profits. With two exceptions, this figure was the lowest reported for 86 industries. The industry, it is stated, needs to focus its attention upon adequate profit margins rather than upon volume at any price. The appendix contains 53 tables and 54 charts in color.

Economics of the Cotton Textile Industry meets a widespread need for a fact book on the industry it covers. Although one or two of the statements made in the text can be questioned, it is generally clear and to the point. The statistics are well selected and well arranged. In all, the volume is a valuable reference source which textile executives and others with an interest in the cotton textile industry would do well to have close at hand.

1946 Directory Number, Linens and Domestics, 32, Number 4A. New York, Haire Publishing Co., July 8, 1946. 194 pp. Price, $1.00.

(*Reviewed by Robert B. Evans*)

This second annual directory gives ". . . a complete list of manufacturers of all types of towels, sheets, blankets, comforters, pillows, tufted bedspreads and bath mats, jacquard bedspreads, decorative and foreign linens, shower and window curtains, Chinese and Madeira goods, towelling, etc. . . ." A listing of trade names is also given. The directory is stated to be the only one covering its field. A sales guide including data on production of linens and domestics, and a bibliography of terms used in selling blankets and sheets and in retail selling generally are included.

ABSTRACTS

SERVICES AVAILABLE

Reprints of the original articles abstracted in TEXTILE RESEARCH JOURNAL *are often available from the publishers. Otherwise, it may be possible to secure copies of the periodicals. Orders should be sent direct to the publishers.*

Photostat negatives of articles abstracted will be furnished to members of the Institute at a cost of 25 cents per page for pages not exceeding 7 inches in width and 35 cents per page for larger sizes up to 11½ x 14 inches. Photostats of patents are 35 cents a page. Postage will be added.

Microfilm copies and paper enlargements of microfilm may be obtained from: Microfilms Inc., 313 N. First St., Ann Arbor, Mich.; New York Public Library, New York, N. Y.; Yale University Library, New Haven, Conn.; Harvard University Library, Cambridge, Mass.; and Library of Congress, Washington, D. C. Translations may also be obtained from the above sources.

The JOURNAL *is again offering to its subscribers reprints of the Abstracts and Book Reviews sections, printed on one side of the sheet so that the items may be clipped, pasted on cards, and filed for permanent reference. Subscriptions to this service for 1947 are $3.00 each. Orders for this special service should be mailed at once to Textile Research Institute, Inc., 10 East 40th Street, New York 16, N. Y.*

A list of periodicals, the abbreviations used in references to articles, and the addresses of publishers of English language publications is given below.

List of Periodicals Abstracted

American

Name and Address of Journal	*Customary Abbreviation*
American Dyestuff Reporter 1 Madison Ave., New York 10, N. Y.	Am. Dyestuff Reptr.
American Journal of Physics American Institute of Physics, Inc. 57 E. 55th St., New York 22, N. Y.	Am. J. Physics
American Journal of Science New Haven, Conn.	Am. J. Sci.
American Society for Testing Materials, Bulletin 1916 Race St., Philadelphia 3, Pa.	ASTM Bull.
American Wool and Cotton Reporter 530 Atlantic Ave., Boston 10, Mass.	Am. Wool and Cotton Reptr.
Bell System Technical Journal, The American Telephone and Telegraph Co. 195 Broadway, New York 7, N. Y.	Bell System Tech. J.
Bibliography of Scientific and Industrial Reports U. S. Department of Commerce, Office of Technical Services Washington 25, D. C.	Bib. Sci. and Ind. Reports
Bulletin of the Institute of Paper Chemistry Appleton, Wis.	Bull. Inst. Paper Chem.
Bulletin of the Lowell Textile Institute Lowell, Mass.	Bull. Lowell Textile Inst.
Calco Technical Bulletin American Cyanamid Co., Calco Chemical Div., Bound Brook, N. J.	Calco Tech. Bull.
Chemical Abstracts Ohio State University, Columbus 10, Ohio	Chem. Abstr.

Name and Address of Journal	*Customary Abbreviation*
Chemical and Engineering News 1155 16th St., N.W., Washington 6, D. C.	Chem. and Eng. News
Chemical Industries 522 Fifth Ave., New York 18, N. Y.	Chemical Industries
Chemical and Metallurgical Engineering 330 W. 42nd St., New York 18, N. Y.	Chem. and Met. Eng.
Chemical Reviews Mt. Royal and Guilford Aves., Baltimore, Md.	Chem. Rev.
Chemist-Analyst, The J. T. Baker Chemical Co., Phillipsburg, N. J.	Chemist-Analyst
Chemurgic Digest 50 W. Broad Tower, Columbus, Ohio	Chemurgic Digest
Chronica Botanica (The International Plant Science News Magazine) Chronica Botanica Co., Waltham, Mass.	Chronica Botan.
Cord Age Magazine Floral Park, L. I., N. Y.	Cord Age Mag.
Cotton 1020 Grant Building, Atlanta 3, Ga.	Cotton
Electronic Industries 480 Lexington Ave., New York 17, N. Y.	Electronic Ind.
Electronics 330 W. 42nd St., New York 18, N. Y.	Electronics
Experimental Station Record Supt. of Documents, Government Printing Office Washington 25, D. C.	Expt. Sta. Record
Fibre and Fabric Wade Publishing Co., 465 Main St., Cambridge, Mass.	Fibre and Fabric
Foreign Agriculture U. S. Bureau of Agricultural Economics, Washington, D. C.	Foreign Agri.
Foreign Commerce Weekly Supt. of Documents, Government Printing Office Washington 25, D. C.	Foreign Commerce Weekly
Fortune 350 5th Ave., New York 1, N. Y.	Fortune
India Rubber World 420 Lexington Ave., New York 17, N. Y.	India Rubber World
Industrial and Engineering Chemistry Industrial and Engineering Chemistry, Analytical Edition 1155 16th St., N.W., Washington 6, D. C.	Ind. Eng. Chem. Ind. Eng. Chem., Anal. Ed.
Interchemical Review 432 W. 45th St., New York 19, N. Y.	Interchem. Rev.
Journal of Agricultural Research Supt. of Documents, Government Printing Office Washington 25, D. C.	J. Agr. Research
Journal of the American Chemical Society 120 Oxford St., Cambridge, Mass.	J. Am. Chem. Soc.

Name and Address of Journal	*Customary Abbreviation*
Journal of the American Leather Chemists Association 143 W. 20th St., New York 11, N. Y.	J. Am. Leather Chem. Assoc.
Journal of the American Society of Agronony Iowa State College, Ames, Iowa	J. Am. Soc. Agron.
Journal of Applied Physics 57 E. 55th St., New York 22, N. Y.	J. Applied Phys.
Journal of the Association of Official Agricultural Chemists Box 540, Benjamin Franklin Station, Washington, D. C.	J. Assoc. Official Agr. Chem.
Journal of Biological Chemistry Mt. Royal and Guilford Aves., Baltimore, Md.	J. Biol. Chem.
Journal of Chemical Education 20th and Northampton Sts., Easton, Pa.	J. Chem. Ed.
Journal of Chemical Physics 57 E. 55th St., New York 22, N. Y.	J. Chem. Phys.
Journal of Colloid Science Academic Press, Inc., 125 E. 23rd St., New York 10, N. Y.	J. Colloid Sci.
Journal of the Franklin Institute Benjamin Franklin Parkway at 20th St., Philadelphia, Pa.	J. Franklin Inst.
Journal of Home Economics American Home Economics Association Mills Bldg., Washington, D. C.	J. Home Econ.
Journal of the Optical Society of America American Inst. of Physics, 57 E. 55th St., New York 22, N. Y.	J. Opt. Soc. Am.
Journal of Organic Chemistry Mt. Royal and Guilford Aves., Baltimore, Md.	J. Org. Chem.
Journal of Physical Chemistry Mt. Royal and Guilford Aves., Baltimore, Md.	J. Phys. Chem.
Journal of Polymer Research Interscience Publishers, Inc. 215 4th Ave., New York 3, N. Y.	J. Polymer Research
Journal of Research, National Bureau of Standards Washington 25, D. C.	J. Research Natl. Bur. Standards
Kodak Research Laboratories, Monthly Abstract Bulletin Eastman Kodak Co., Rochester, N. Y.	Kodak Mo. Abstr. Bull.
Manufacturers' Record Manufacturers' Record Publishing Co. Commerce and Water Sts., Baltimore, Md.	Mfrs'. Record
Mechanical Engineering The American Society of Mechanical Engineers 29 W. 39th St., New York 18, N. Y.	Mech. Eng.
Modern Industry 347 Madison Ave., New York 17, N. Y.	Modern Ind.
Modern Plastics 122 E. 42nd St., New York 17, N. Y.	Modern Plastics
Oil and Soap Gillette Publishing Co., 400 W. Madison St., Chicago, Ill.	Oil and Soap

Name and Address of Journal	*Customary Abbreviation*
Pacific Plastics Los Angeles, Calif.	Pacific Plastics
Paper Mill and Wood Pulp News L. D. Post, Inc., 1440 Broadway, New York 18, N. Y.	Paper Mill News
Paper Trade Journal 15 W. 47th St., New York 19, N. Y.	Paper Trade J.
Physical Review The American Inst. of Physics, 57 E. 55th St., New York 22, N. Y.	Phys. Rev.
Plastics Ziff-Davis Publishing Co., Chicago, Ill.	Plastics (Chicago)
Plastics and Resins 299 Madison Ave., New York 17, N. Y.	Plastics and Resins
Product Engineering 330 W. 42nd St., New York 18, N. Y.	Product Eng.
Rayon Organon 10 E. 40th St., New York 16, N. Y.	Rayon Organon
Rayon Textile Monthly 303 5th Ave., New York 16, N. Y.	Rayon Text. Mo.
Record of Chemical Progress Friends of Hooker Scientific Library Central College, Fayette, Mo.	Record Chem. Progress
Review of Scientific Instruments 57 E. 55th St., New York 22, N. Y.	Rev. Scientific Instruments
Reviews of Modern Physics 57 E. 55th St., New York 22, N. Y.	Rev. Modern Phys.
Rubber Age 250 W. 57th St., New York 19, N. Y.	Rubber Age (New York)
Rubber Chemistry and Technology 1012 Second National Building, Akron 1, Ohio	Rubber Chem. Tech.
Saco-Lowell Bulletin, Saco-Lowell Shops 60 Batterymarch St., Boston, Mass.	Saco-Lowell Bull.
Science The Science Press, Lancaster, Pa.	Science
Soap and Sanitary Chemicals 254 W. 31st St., New York 1, N. Y.	Soap San. Chem.
Synthetic Organic Chemicals Eastman Kodak Co., Rochester, N. Y.	Synthetic Org. Chemicals
Technology Review Mass. Inst. of Technology, Cambridge, Mass.	Tech. Rev.
Textile Age 381 4th Ave., New York 16, N. Y.	Textile Age
Textile Bulletin 218 W. Morehead St., Charlotte, N. C.	Textile Bulletin

Name and Address of Journal	*Customary Abbreviation*
Textile Colorist and Converter 1 Madison Ave., New York 10, N. Y.	Text. Col. and Converter
Textile World 330 W. 42nd St., New York 18, N. Y.	Textile World

British Empire

Biochemical Journal, The Cambridge University Press, Fetter Lane, London E.C. 4, England	Biochem. J.
British Plastics Dorset House, Stamford St., London S.E. 1, England	Brit. Plastics
Canadian Chemistry and Process Industries 137 Wellington St. W., Toronto 1, Ont.	Can. Chem. and Proc. Ind.
Canadian Journal of Research National Research Council, Ottawa, Canada	Can. J. Research
Canadian Textile Journal 1434 St. Catherine St. W., Montreal, Canada	Can. Text. J.
Chemistry and Industry 56 Victoria St., London S.W. 1, England	Chemistry and Industry
Current Science Indian Institute of Science, Hebbal P. O., Bangalore, India	Current Science
Dyer, Textile Printer, Bleacher and Finisher, The Heywood & Co., Ltd., Drury House, Russel St., Drury Lane, London W.C. 2, England	Dyer
Engineer, The 28 Essex St., Strand, London W.C. 2, England	The Engineer
Fibres 17 Stratford Place, London W. 1, England	Fibres
Indian Textile Journal Military Square, Fort Bombay, India	Indian Text. J.
Journal of the Chemical Society Burlington House, London W. 1, England	J. Chem. Soc.
Journal of the Council for Scientific and Industrial Research 314 Albert St., E. Melbourne, Victoria, Australia	J. Council Sci. Ind. Research
Journal of the Indian Chemical Society 92 Upper Circular Rd., Calcutta, India	J. Indian Chem. Soc. J. Indian Chem. Soc., Ind. and News Ed.
Journal of the Institution of Electrical Engineers (London), The Savoy Place, Victoria Embankment, London W.C. 2, England	J. Inst. Elec. Engrs.
Journal of Scientific and Industrial Research (India) Council of Scientific and Industrial Research, New Delhi, India	J. Sci. and Ind. Research
Journal of Scientific Instruments Institute of Physics, Lowther Gardens, Exhibition Rd., South Kensington, London S.W. 7, England	J. Sci. Instruments
Journal of the Society of Chemical Industry 56 Victoria St., London S.W. 1, England	J. Soc. Chem. Ind.

Name and Address of Journal	*Customary Abbreviation*
Journal of the Society of Dyers and Colourists The University, Leeds, England	J. Soc. Dyers and Colourists
Journal of the Textile Institute 16 St. Mary's Parsonage, Manchester, England	J. Text. Inst.
Jute and Canvas Review London, England	Jute and Canvas Rev.
Nature Macmillan & Co., Ltd., St. Martin's St., London, England	Nature
New Zealand Journal of Science and Technology Government Printer, Wellington, N. Z.	New Zealand J. Sci. and Tech.
Paper-Maker and British Paper Trade Journal, The 47 Cannon St., London E.C. 4, England	Paper-Maker
Physics Abstracts Inst. of Electrical Engineers, Savoy Place, Victoria Embankment, London W.C. 2, England	Phys. Abstr.
Proceedings of the Physical Society 1 Lowther Gardens, London S.W. 7, England	Proc. Phys. Soc.
Proceedings of the Royal Society Cambridge University Press, 200 Easton Rd., London N.W. 1, England	Proc. Roy. Soc.
Science and Culture Indian Press, Ltd., 93A Dhurrumtola St., Calcutta, India	Science and Culture
Shirley Institute Memoirs Didsbury, Manchester, England	Shirley Inst. Memoirs
Silk and Rayon St. James House, 44 Brazennose St., Manchester 2, England	Silk and Rayon
Silk Journal and Rayon World Old Colony House, S. King St., Manchester 2, England	Silk J. Rayon World
Textile Journal of Australia 19–47 Jeffcott St., Melbourne, Australia	Text. J. Australia
Textile Manufacturer 21 Bedford St., Strand, London W.C. 2, England	Text. Mfr.
Textile Mercury and Argus 41 Spring Gardens, Manchester, England, or 146 Fleet St., London E.C. 4, England	Text. Mercury and Argus
Textile Recorder Old Colony House, S. King St., Manchester, England	Text. Recorder
Textile Weekly, The The Textile Press, Ltd., 49 Deansgate, Manchester 3, England	Text. Weekly
Transactions of the Faraday Society 33 Paternoster Row, London, England	Trans. Faraday Soc.
Dutch	
Recueil des travaux chimiques des Pays-Bas	Rec. Trav. Chim.

Name of Journal	*Customary Abbreviation*
Finnish	
Finnish Paper and Timber Journal	Finnish Paper Timber J.
French	
Annales de chimie	Ann. chim.
Bulletin de la société chimique de France (Documentation and Mémoires)	Bull. soc. chim. Mem. Bull. soc. chim. Documentation
Chimie & industrie	Chimie & industrie
Comptes rendus hebdomadaires des séances de l'académie des sciences	Compt. rend.
Journal de chimie physique et Revue générale des colloïdes	J. chim. phys.
Plastiques	Plastiques
Teintex	Teintex
German	
Angewandte Chemie	Angew. Chem.
Berichte der deutschen chemischen Gesellschaft	Ber.
Cellulosechemie	Cellulosechem.
(Die) Chemie	Chemie
Chemisches Zentralblatt	Chem. Zentr.
Collegium	Collegium
Deutsche Färber-Zeitung	Deut. Färber-Zeit.
Journal für makromolekulare Chemie	J. makromol. Chem.
Journal für practische Chemie	J. pract. Chem.
Klepzigs Textil-Zeitschrift	Klepzigs Textil-Z.
Kolloid-Zeitschrift	Kolloid-Z.
Kunstseide und Zellwolle	Kunstseide u. Zellwolle
Melliand Textilberichte	Melliand Textilber.
Naturwissenschaften	Naturwissenschaften
Planta	Planta
Spinner und Weber	Spinner u. Weber
Wasser und Abwasser	Wasser u. Abwasser
Zeitschrift für Elektrochemie und angewandte physikalische Chemie	Z. Elektrochem.
Zeitschrift für physikalische Chemie	Z. physik. Chem.
Zeitschrift des Vereines deutscher Ingenieure	Z. Ver. deut. Ing.
Zellwolle, Kunstseide, Seide	Zellwolle, Kunstseide, Seide

Name of Journal	*Customary Abbreviation*
Irish	
Fibres, Fabrics and Cordage	Fibres, Fabrics and Cordage
Italian	
Laniera	Laniera
Russian	
Bulletin de l'académie des sciences de l'Union des Républiques Soviétiques Socialistes	Bull. acad. sci. URSS
Comptes rendus (Doklady) de l'académie des sciences de l'U.R.S.S. (In English, French or German)	Compt. rend. acad. sci. URSS
Izvestiya Akademii Nauk Soyuza Sovetskikh Sotsialisticheskikh Respublik (for the most part, in Russian)	Izvest. Akad. Nauk SSSR
Journal of Applied Chemistry (USSR)	J. Applied Chem. (USSR)
Journal of Technical Physics (USSR)	J. Tech. Phys. (USSR)
Legkaya Promyshlennost (Light Industry)	Legkaya Prom.
Shelk	Shelk
Trudy Konferentsiĭ Vysokomolekulyar	Trudy Konferentsiĭ Vysokomolekulyar
Swedish	
Svensk Kemisk Tidskrift	Svensk Kem. Tid.
Svensk Papperstidning	Svensk Papperstidn.
Teknisk Tidskrift	Tek. Tid.
Swiss	
Experientia	Experientia
Helvetica Chimica Acta (In French, German, or Italian)	Helv. Chim. Acta
Schweizer Archiv für angewandte Wissenschaft und Technik	Schweiz. Arch. angew. Wiss. Tech.
Vierteljahrsschrift der naturforschenden Gesellschaft in Zürich	Vierteljahrsschr. naturforsch. Ges. Zürich

ABSTRACTS

ANALYSIS: TESTING: LABORATORY METHODS

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Plastic Capillaries

Laboratory preparation of thin-walled plastic capillaries. Robert K. Ness. *Rev. Scientific Instruments* **17**, 344 (Sept. 1946).

Short lengths of thin-walled polystyrene capillaries for use in x-ray diffraction work may be prepared by coating the inside of a glass capillary with a solution of the plastic, allowing the coating to harden, and then removing the glass capillary. The details of a method for so doing are explained.

Text. Research J. Jan. 1947 T. J. Dietz

Colorimetry of Textiles

Standard angular conditions for the colorimetry of textiles. E. I. Stearns. *Am. Dyestuff Reptr.* **35**, P330–1 (July 1, 1946).

Although the importance of standard angular conditions of view in visual color matching and in instrumental textile colorimetry has long been recognized, there is as yet no well-defined and widely accepted standard method of viewing textile samples. Some of the problems involved in obtaining standard viewing conditions are discussed and comment is made on the solution adopted by the National Bureau of Standards in its measurement of the TCCA samples. K. S. Campbell

Text. Research J. Jan. 1947

Dielectric Constants of Cotton

Dielectric properties of raw cotton. W. Lawrence Balls. *Nature* **158**, 9 (July 1946).

A rather detailed description is given of the experimental procedure used for measuring the dielectric constant of cotton in fields which traversed the hair both lengthwise and in the transverse direction. The values of K for cotton dried at 100°C were found to be about 6 longitudinally and 3 in the transverse direction. The value for the longitudinal direction increases somewhat more rapidly with increasing moisture content than does that for the transverse direction. Similar results were found when wooden blocks were used instead of cotton hairs. R. W. Eyler

Text. Research J. Jan. 1947

Electron Microscopy

Thin undistorted sections for electron microscopy. H. C. O'Brien, Jr., and James W. McBain. *J. Am. Chem. Soc.* **68**, 1139 (June 1946).

The high-speed ultramicrotome (*Rev. Scientific Instruments* **17**, 23) has been used to prepare samples of floating-tallow, coconut-oil soap for use with the electron microscope. The resulting electron micrographs show no smearing or distortion of the air spaces. It is suggested that the enclosed cell of McBain and Abrams (*J. Applied Phys.* **15**, 607) could be used to preserve sections for use. A. R. Macormac

Text. Research J. Jan. 1947

Supplementary bibliography of electron microscopy. Mary E. Rathbun, Mary J. Eastwood, and Orlan M. Arnold. *J. Applied Phys.* **17**, 759–62 (Oct. 1946).

A list of references in electron microscopy not included in the bibliography of C. Marton and S. Sass, *J. Applied Phys.* **14**, 522–31 (1943); **15**, 575–9 (1944); **16**, 373–8 (1945). 139 references.

Text. Research J. Jan. 1947 T. J. Dietz

A method for preparing rubber latex specimens for the electron microscope. R. H. Kelsey and E. E. Hanson. *J. Applied Phys.* **17**, 675–7 (Aug. 1946).

Specimens of natural or synthetic rubber latices may be prepared for examination in the electron microscope by mixing the latex with an aqueous solution of polyvinyl alcohol and casting a film from this mixture. Agglomeration of particles is prevented during mixing by rapidly agitating the suspension. A detergent is useful in promoting the wetting of the wire specimen screen with the polyvinyl alcohol dispersion. This technique is said to yield more representative specimens than the usual collodion film method in that the present method does not cause distortion or flattening of the latex particles.

Text. Research J. Jan. 1947 T. J. Dietz

Electronic Spectroscopy

Electronic spectroscopy. George C. Sziklai and Alfred C. Schroeder. *J. Applied Phys.* **17**, 763–7 (Oct. 1946).

When a cyclic electromotive force (saw-toothed) is applied to a photoelectric cell, and the cell is illuminated with heterochromatic light, the total current generated by the cell is the aggregate of the individual currents for each of the monochromatic bands comprising the radiation. For each wave length in the spectral distribution of the light, the flow of current in the photoelectric cell starts at a threshold value of the applied potential which is characteristic of the emitting surface and the wave length of the impinging light. The authors describe an electronic circuit which performs a double differentiation upon the signal from the photoelectric cell and traces the resulting curve upon an oscilloscope. It is possible to use this system as a simple color analyzer because the tracing on the oscilloscope screen represents the spectral distribution of the light impinging on the photoelectric cell. T. J. Dietz

Text. Research J. Jan. 1947

Fiber Arrays

Fiber-array technique—simplify it for mill use. Seth Carter. *Textile World* **96**, 153, 155, 209 (July 1946).

The use of a short-cut method of making and evaluating fiber arrays is explained, although there is very little on the actual technique of

making the array. Apparently the sampling is done and array laid down the same as in the U. S. Dept. of Agriculture method. It is said that maximum, mean, upper-quartile, upper-mean-classified, and all other length values can be read directly from a chart of the array with no weighing and little computing. The author claims that comparisons made between results obtained by this method and by other methods show that indicated values are as precise and are actually more consistent when this simplified method is used. H. J. Burnham

Text. Research J. Jan. 1947

Fiber Testing

Periodic precipitations in the case of native and regenerated cellulose fibers. G. Schramm. *Kolloid-Z.* **108**, 166–9 (Aug., Sept. 1944) (in German) (through *Bull. Inst. Paper Chem.* **17**, 62 (Oct. 1946)).

An attempt was made to differentiate between native cotton and regenerated cellulose fibers by the formation of rhythmic precipitations of silver iodide, by placing the fiber first in aqueous potassium iodide and subsequently in a silver-nitrate solution. Some differences were indicated in the photomicrographs of three different viscose fibers and one sample of Egyptian cotton fiber, but the general conclusion was reached that cellulose shows a behavior very similar to that of other types of gels which give rise to the Liesegang ring phenomenon. The possible connection between differences in "ring formation" and structural differences of the fibers is left for a future communication.

Text. Research J. Jan. 1947

X-Ray Fiber Diagrams

Quantitative evaluation of orientation in cellulose fibers from the x-ray fiber diagram. J. J. Hermans, P. H. Hermans, D. Vermaas, and A. Weidinger. *Rec. trav. chim.* **65**, 427–47 (July, Aug. 1946) (in English) (through *Bull. Inst. Paper Chem.* **17**, 102 (Oct. 1946)).

The theory of fiber diagrams as given by Polanyi and first applied to cellulose fibers by Sisson and Kratky enables one to derive the orientation in a fiber from the intensity distribution in the diatropic interferences. Since these interferences are usually too weak in the x-ray diagrams of cellulose fibers, one must resort to the paratropic reflections. The present paper shows how these paratropic reflections must be evaluated to obtain the orientation factor (*fr*) as a rational measure of average orientation. It is shown on experimental grounds that the proximity of the A_4 interference does not invalidate the evaluation of the A_3 sickle. A special procedure must be applied to fibers in which the orientation is not very pronounced, since here the interferences of the (021) planes partly overlap those of the paratropic A_3 planes. It is assumed throughout this article that, in all experiments, the Bragg angle is negligible. The correction required when dealing with finite Bragg angles is discussed, as well as the relation between orientation and optical constants. Finally, an illustration and a short summary of the method are given. 18 footnotes.

Text. Research J. Jan. 1947

Extracts of Irish Moss

A method of measuring the stabilizing power of extracts of Irish moss. F. A. H. Rice. *Can. J. Research* **24B**, 20–7 (Jan. 1946).

The method involves precipitation of calcium oxalate in the gelose solution by adding equivalent amounts of calcium chloride and sodium oxalate, centrifuging for a definite length of time and determining the amount of calcium oxalate remaining in suspension. Data are presented on reproducibility, effect of time of standing before centrifuging, temperature, pH, and added neutral salts. The results are not sensitive to moderate variations in these factors. An equation containing three empirical constants is derived relating amount of oxalate remaining suspended to gelose concentration and time of centrifuging. The values of one of these constants for a series of gelose preparations are correlated with their stabilizing power for chocolate in chocolate milk. W. E. Davis

Text. Research J. Jan. 1947

Infrared Absorption Cell

Infrared absorption cell for liquids. Norman D. Coggeshall. *Rev. Scientific Instruments* **17**, 343–4 (Sept. 1946).

An infrared absorption cell for liquids is described. The cell consists of two rock salt plates, the windows, separated by an amalgamated lead spacer or shim. The windows are secured by four bolts through suitable backing plates cushioned on amalgamated lead shims. Two needle valves of special design are provided for cleaning and filling the cell. The author states that the cell is vapor-tight and capable of retaining quite volatile liquids for long periods of time.

Text. Research J. Jan. 1947 T. J. Dietz

Molecular Weight Distributions

Molecular weight distribution data on high polymers—graphical representation. R. E. Boyer. *Ind. Eng. Chem., Anal. Ed.* **18**, 342–8 (June 1946).

This article describes the preparation and use of a series of graph papers designed to convert cumulative molecular weight distribution data for high polymers into straight lines. These graph papers are based on a theoretical 2-parameter molecular-weight distribution equation derived by Schulz from statistical considerations of the mechanism of vinyl-type polymerizations. It was found that most of the published molecular-weight distribution data on vinyl polymers, cellulose, and cellulose derivatives will give fairly linear plots on these graph papers. In no case, however, is a perfect fit obtained. This failure, in the case of vinyl polymers, is tentatively ascribed to the simultaneous operation of several kinetic mechanisms during polymerization and/or to faulty fractionation techniques. Various mathematical criteria for judging molecular-weight distribution data are included, as is also a brief reference to the general use of

these graph papers on unsymmetrical frequency distributions.

Text. Research J. Jan. 1947 Author

Identification of Mordant Dyes

The detection of mordant treatments on dyed strand or fabric samples. A. Herrmann. *Allgem. Textil-Z.* **2**, 215–16 (1944) (through *Chem. Abstr.* **40**, 5924[7] (Oct. 10, 1946)).

Ashing leaves reddish-brown, green, white, or black residues showing that Fe, Cr, alumina, or Cu compounds were used. For a more accurate analysis fuse the textile with $Na_2CO_3 + NaNO_3$, cool, dissolve in HCl, and subject to a standard chemical analysis. Specific tests are given for the identification of Turkey red, alizarin dyeing, indigo, and black dyes in the textile.

Text. Research J. Jan. 1947

Vinyl Polymerization

Determination of the velocity constants in the polymerization of vinyl compounds. C. H. Bamford and M. J. S. Dewar. *Nature* **157**, 845 (June 1946).

A procedure is reported for determining the absolute values of the 4 velocity constants for the accepted mechanism for polymerization of vinyl compounds: initiation (k_1), chain propagation (k_2), chain transfer (k_3), and termination (k_4).

Text. Research J. Jan. 1947 R. W. Eyler

Precision Timing Circuits

Some precision circuit techniques in wave-form generation and time measurement. Britton Chance. *Rev. Scientific Instruments* **17**, 396–415 (Oct. 1946).

This paper contains a survey of the characteristics and uses of nonlinear circuit elements in the generation of wave-forms particularly useful in precision timing circuits. The use of these nonlinear circuit elements in detection and time measurement is also included. Author

Text. Research J. Jan. 1947

Fibrillation of Rayon

Fibrillar structure of rayon fibers. L. M. Welch, W. E. Roseveare, and H. Mark. *Ind. Eng. Chem.* **38**, 580–2 (June 1946).

Single rayon filaments are mounted on glass slides under an optical microscope and covered with a thin glass slide. A small amount of 70% nitric acid is placed on the end of the cover glass in contact with the specimen. The rayon swells as the nitric acid penetrates. A slight pressure on the cover glass causes the filament to disintegrate into fibrils. By this technique the fibrillar structure of rayon and other fibers may be investigated. In a highly orientated viscose rayon yarn, the fibrils are orientated parallel to the fiber axis. High-tenacity saponified cellulose acetate filaments show a similar structure except that there are fewer cross-overs of the fibrils than in the highly orientated viscose yarn. In tire yarn, the filaments do not split spontaneously into fibrils but tend at first to stick together in comparatively large filamentlike structures which upon additional pressure break down into fibrils of about the same size as those obtained from the highly orientated yarn. Filaments of ordinary viscose yarn do not break down into fibrils but disintegrate to give irregularly shaped pieces of cellulose. Cotton and ramie under the same condition give similar fibrils but they are orientated at an angle to the fiber axis. A number of photomicrographs and x-ray diagrams are given.

A. R. Macormac

Text. Research J. Jan. 1947

Rayon-Bast Mixtures

The influence of the addition of staple rayon on the results of the quantitative chemical analysis of staple rayon-flake bast mixtures. Karl Buschmann. *Allgem. Textil-Z.* **2**, 120–1 (1944) (through *Chem. Abstr.* **40**, 5927[4] (Oct. 10, 1946)).

The data given show that if the method (*C.A.* **37**, 3613[9]) is used, the correction factor found for pure flake bast may be used also for mixtures of 50:50 viscose staple rayon-flake bast.

Text. Research J. Jan. 1947

Reflectance of Dyed Fibers

The cellulose-dyestuff complex. Part 2—The intensity of light reflected from dyed fibers. J. M. Preston and P. C. Tsien. *J. Soc. Dyers and Colourists* **62**, 242–8 (Aug. 1946).

A model is proposed from which to calculate the light reflected from dyed fibers. An explicit relationship between reflected light intensities and dye concentrations is derived from the model and gives a reasonable fit to experimental measurements on dyed fibers. Authors

Text. Research J. Jan. 1947

Rheology

Methods of calculating and representing rheological properties, using data from the parallel-plate plastometer. J. R. Scott. *Rubber Chem. Tech.* **19**, 461–5 (Apr. 1946).

Outlines an approximate and an exact method for obtaining the constants in the equation of flow for a pseudo-viscous material, from data obtained with the parallel-plate Williams plastometer. Methods of obtaining linear graphs of flow data, which facilitate comparison of different samples, are also given, as well as a formula for mean shear stress in the sample. W. E. Davis

Text. Research J. Jan. 1947

Viscometry

A photographic-viscometric apparatus and technique. Jesse L. Riley and George W. Seymour. *Ind. Eng. Chem., Anal. Ed.* **18**, 387–90 (June 1946).

An apparatus and a procedure for the accurate determination of flow times of dilute solutions in the Ostwald-type viscometer have been developed. Means of measurement and control of the viscometric variables have been designed on the principle of making approximately equal contributions to the final error. A unique feature of the apparatus is the automatic timing device. Motion pictures are made

of the meniscus transits in the viscometer and of the virtual image of an accurate, electronically operated clock. Times of transit are interpolated from the pictures to 0.001 sec. Corrected flow times of 3 or 4 check runs for each of 3 cellulose acetate solutions in dioxane ranging from 0.01 to 0.3% concentrations fell within a time range of 0.005%. Authors

Text. Research J. Jan. 1947

CHEMICAL AND PHYSICAL RESEARCH

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Derivative of Methyl Cellulose

Chlorophenyl carbamates of methyl cellulose. Elizabeth Dyer and Katherine L. McCormick. *J. Am. Chem. Soc.* **68**, 986–7 (June 1946).

The *o*- and *p*-chlorophenylcarbamates of methyl cellulose were prepared by heating dry methyl cellulose containing some free hydroxyls and the chlorophenyl isocyanates in dry pyridine for 4–6 hrs. at 65°C. The products were purified by treatment with solvents. Viscosity determinations indicate that little degradation had taken place. Analysis indicates that complete substitution was obtained. The compounds are soluble in acetone, dioxane, pyridine, and chloroform, and insoluble in methanol or water. A. R. Macormac

Text. Research J. Jan. 1947

Color and Constitution

Colour and constitution. Part VIII. Some colour problems from the viewpoint of resonance theory. H. H. Hodgson. *J. Soc. Dyers and Colourists* **62**, 237–40 (Aug. 1946); cf. *T.R.J.* **16**, 93 (Feb. 1946).

H. E. Armstrong's quinonoid and triple color-center hypotheses are discussed from the standpoint of modern resonance theory, on which the quinonoid system is only one type of oscillating system which can exhibit resonance. The older theory fails completely to explain the colors of the aliphatic nitroso compounds and the absence of color in *p,p'*-quinonediimine, as well as the enhanced color of quinhydrone. The earlier attempts, however, laid the foundation for the later quasi-quantitative theory. That Armstrong should take iodoform as a reference substance in his wider generalization indicated beyond doubt the necessity for a theory such as that provided by the concept of resonance. Author

Text. Research J. Jan. 1947

Macromolecules in Solution

Size and shape of macromolecules in solution. P. M. Doty and H. Mark. *Ind. Eng. Chem.* **38**, 682–6 (July 1946).

Polymer molecules are chainlike or threadlike structures of very small cross-sectional area. Consequently, although the coiled molecule may extend over distances of several thousand Å. units, the determinations of its size, shape, and weight are not susceptible to most of the direct methods used for particle-size determination of more compact particles. Indirect methods of determining the size of polymer molecules are reviewed here with the hope that they may be applicable to the determination of particle size of other substances where the ordinary direct methods fail or need corroboration. Methods based on the ultracentrifuge, on osmotic pressure, on light-scattering, and on streaming birefringence are discussed. 41 references. Authors

Text. Research J. Jan. 1947

Polymerization

Oxygen as activator and deactivator of polymerization. Dr. Heuck (translated by Mrs. I. G. Callomon and G. M. Kline). (*Modern Plastics* **24**, 158–62, 208, 210, 212 (Dec. 1946)).

Activation of low-molecular-weight monomers is initiated by peroxides or atomic oxygen liberated from these peroxides by water or hydrogen ions of the aqueous dispersion agent—depending on the reaction temperature. Opposed to the activating reaction there is a deactivating reaction which occurs when molecular oxygen adds itself to the activated monomer. The deactivating reaction has a marked effect on the induction period in polymerization. Exclusion of oxygen, normally present in uncontrolled amount in the reaction vessel and dissolved in the aqueous phase, has led to more reproducible results and a more uniform polymer. The oxygen content of water depends on various factors, especially on temperature. This fact might perhaps explain the often-observed varying onset of polymerization in otherwise identical compositions. On the basis of this new finding, it is necessary to watch the chemicals used in emulsion polymerization for the existence of impurities having reducing action. The presence of a very small amount of a reducing agent can shorten the induction period and decrease the K-value. The *moloxides*, which are either present in the monomer or develop in contact with air, decompose only at higher temperatures than the peroxides (potassium persulfate or hydrogen peroxide) used as activators. Therefore, the decrease in the induction period becomes more evident in comparative tests made at low temperatures. Author

Text. Research J. Jan. 1947

Polyuronide Esters

The acylation of polyuronides with formamide as a dispersing agent. J. F. Carson and W. D. Maclay. *J. Am. Chem. Soc.* **68**, 1015–17 (June 1946).

Polyuronides are dispersed in formamide to a smooth paste or a viscous solution. The amount of formamide varies with the polysaccharide and depends on the viscosity of the dispersion. Pyridine is added gradually to the formamide paste; then the appropriate acid anhydride is used for esterification. Acetates were more difficult to prepare than propionates or butyrates. Esters of pectin, pectic acid, alginic acid, gum tragacanth, gum arabic, and starch were prepared and characterized.

The method should be generally useful for polysaccharides which are dispersible in formamide.

A. R. Macormac

Text. Research J. Jan. 1947

Effect of Nitrogen on Mildew Growth

The effect of nitrogen on the growth of *Chaetomium globosum* on cotton canvas. F. R. Romano. *Am. Dyestuff Reptr.* **35**, 363–4, 375–6 (July 29, 1946).

Experiments to determine whether an increased growth of *Chaetomium globosum* could be induced by increasing the amount of nitrogen in the nutrient medium showed that the nitrogen concentrations of the nutrients in general use are insufficient for maximum growth. A definite, increased growth response was had with nutrient media containing 1.400 to 1.750 g. of nitrogen, as NH_4NO_3, per liter. Concentrations of nitrogen, as NH_4NO_3, as high as 7.330 g. per liter are not inhibitory to *Chaetomium globosum*.

K. S. Campbell

Text. Research J. Jan. 1947

Polyvinyl Alcohol

The structure of polyvinyl alcohol. A. D. McLaren and R. J. Davis. *J. Am. Chem. Soc.* **68**, 1134–5 (June 1946).

Oxidation of polyvinyl alcohol solutions (0.1 to 1.0%) with periodic acid indicates that the 1.2-glycol structure was present to about 1.9%. The reaction is very slow at zero but complete in 6 to 18 hrs. at 25°C. Viscosity measurements confirm this result. Polymer solutions, 2% or stronger, continue to react with periodic acid for some unknown reason.

A. R. Macormac

Text. Research J. Jan. 1947

Solubility of Sericin

The effect of salts and pH on the solubility of sericin. M. V. Korchagin and A. F. Pirozhnikova. *Tekstil'naya Prom.* **6**, No. 4/5, 29–31 (1946) (through *Chem. Abstr.* **40**, 5928[7] (Oct. 10, 1946)).

The purpose of this investigation was to determine the peptizing action of NaCl, NaBr, and NaI on sericin; to determine the effect of pH and salts on the solubility of sericin; and to test the contention that the rate of degumming of silk depends on the pH but not on the concentration of salts in the medium. One gram of raw silk was introduced in 100 ml. of boiling 0.005–1.0*N* salt solution, and boiling was continued under a reflux condenser for approximately 45 min. The flask was cooled, the liquid filtered, and in the filtrate N was determined microchemically. Sericin was calculated from the N content by using a factor 6. The quantity of sericin dissolved increased with the concentration of the salts. There was a definite optimum concentration of salts beyond which the solubility of sericin did not increase. For NaCl this concentration was 0.25*N*, and for NaBr and NaI 0.01*N*. The effectiveness of the anions taken at the same concentration follows the Hofmeister series, i.e., Cl < Br < I. Generally the peptizing action of the salts was small. The maximum for NaCl was 3.83, for NaBr 3.51, and for NaI 7.31% of sericin dissolved, based on the weight of raw silk. The effect of pH was tested with 0.0025–0.1000*N* phosphate solutions (pH 5.88–7.81). An increase in either concentration or pH increased the solubility of sericin. The effectiveness of PO_4 ion was greater than that of Cl ion. It is concluded that both the pH and the concentration of reagents (salts) influence the solubility of sericin.

Text. Research J. Jan. 1947

BLEACHING: DYEING: FINISHING

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Peroxide Bleaching

Bleaching textiles with peroxides. R. Mills. *Am. Dyestuff Reptr.* **35**, P388–9, 393 (Aug. 12, 1946).

Modern methods of bleaching cotton and wool textiles with peroxides are reviewed; equipment is described and general formulas are given. It is noted that 130-volume (35%) hydrogen peroxide is now commercially available and that higher strengths (up to 85%) developed for war uses can be manufactured.

K. S. Campbell

Text. Research J. Jan. 1947

Bleaching with Ozone

Ozone methods of bleaching yarns or fabrics. E. Howlett. *Text. Mfr.* **72**, 412–14 (Aug. 1946).

A description of method and equipment for preparing ozone by means of a silent electric discharge.

H. J. Burnham

Text. Research J. Jan. 1947

Bleaching Piece Goods

Bleaching piece goods in the cotton-finishing industry. F. H. Thies. *Allgem. Textil-Z.* **2**, 11–16 (1944); cf. *C.A.* **38**, 3138[6] (through *Chem. Abstr.* **40**, 5927[7] (Oct. 10, 1946)).

The significance of the circulation problem is discussed. Historical data are given and various techniques are described, such as Spirk's interpretation of the Barlow-Pendelbury system, alkaline treatments at reduced volume and intermittent boiling, the circulation vehicle and the Boyle-Mariotte law, the Jefferson-Weedon method, etc.

Text. Research J. Jan. 1947

Wool Scouring

Chemical control gives improved wool scouring. A. L. Dubeau and G. P. Vincent. *Am. Dyestuff Reptr.* **35**, 469–71 (Oct. 7, 1946).

Plant experiments showed that an optimum alkalinity ratio, carbonate to bicarbonate, of 1:1 existed for most efficient scouring of shorn or pulled wool. The increased efficiency is explained by the pH (about 9.8) at this optimum ratio, and by the "opening" effect of the bicarbonate on the wool. A new scouring process for shorn wool has been developed which keeps the bicarbonate within the prescribed limits by the addition of controlled amounts of caustic soda which react with the bicarbonate (normally increasing as scouring proceeds) to form carbonate. In the case of pulled wool scouring, however no

bicarbonate is present as it is rapidly converted, if formed, to carbonate by the alkali in the wool; a marked improvement in the scouring of this material may be had by the controlled addition of bicarbonate throughout the process. Bicarbonate control in both scouring processes results in increased rate of scouring, improved wool quality, and reduced costs. K. S. Campbell

Text. Research J. Jan. 1947

Bleaching and Dyeing Jute

A new method of approach to the bleaching and subsequent dyeing of jute. C. Garrett. *J. Soc. Dyers and Colourists* **62**, 234–7 (Aug. 1946).

It has been evident that if the problem of odor and lack of light- and wash-fastness in dyed jute could be overcome the fiber could acquire considerable commercial importance in a field in which it had not previously played a part. Benzene extraction has been found to provide odorless jute and greatly to facilitate its subsequent bleaching and dyeing. Bleaching of jute, which is necessary for the production of good dyed shades, is best carried out with alkaline, mild hypochlorite at 100–120°F, repeating the operation several times with intermediate washing; the result is not a white but a clean cream color. The bleach is not permanent to light and pastel shades are not used because the redarkening of the fiber blots out the original color; full dyed shades, however, prevent the light from striking the fiber and thus prevent shade alteration from this cause. Extensive experimentation has shown that light- and wash-fastness may be obtained by the use of selected direct, azoic, Indigosol, and wool dyes; for best all-round fastness, Indigosols should be used. Interesting tone-in-tone and two-color effects are readily produced on jute-cotton unions. The launderability of jute fabrics may be considerably improved by treatment with a paraffin wax emulsion. Although the cost of processing jute along the lines described is not low, in view of the market situation and the quality obtainable, the operation appears economically feasible.

K. S. Campbell

Text. Research J. Jan. 1947

Bibliography on Color

1945 bibliography of color. I. H. Godlove. *Am. Dyestuff Reptr.* **35**, P408–12, P417 (Aug. 26, 1946).

An unusually valuable and comprehensive bibliography of publications dealing with color and related subjects with brief, informative comment on most of the items mentioned. K. S. Campbell

Text. Research J. Jan. 1947

Color Standards

Benefit to industry of measured standards. J. F. Warner. *Am. Dyestuff Reptr.* **35**, P332–3 (July 1, 1946).

The economic benefits in having measured color standards, as represented by the Textile Color Card Association samples, are discussed.

K. S. Campbell

Text. Research J. Jan. 1947

Filament Thickness

Filament thickness and its significance to the dyer. Anon. *Am. Dyestuff Reptr.* **35**, 455–7 (Sept. 23, 1946).

Reprinted from *The Dyer and Textile Printer*, England. K. S. Campbell

Text. Research J. Dec. 1946

Fluorescence

The colorimetry of fluorescent samples. I. H. Godlove. *Am. Dyestuff Reptr.* **35**, P390–3 (Aug. 12, 1946).

The historical background of technical colorimetry, especially with reference to the intertranslation of the various systems of color standards, is discussed. There now exist I.C.I., Munsell, and ISCC-NBS specifications on the Munsell and on the Textile Color Card Association colors, and Munsell specifications on the Ostwald colors; these all supplement each other. The lack of color names by which to describe the many color groups into which the color solid is divided is noted; of the 312 ISCC-NBS color groups, common names exist for but 183. The physical-chemical basis of color and fluorescence is concisely described. It is pointed out that the dyer, in the attempt to get more brightness and tinctorial strength, incidentally succeeds in obtaining increased fluorescence. In describing a fluorescent sample, the illumination used must be clearly defined. Munsell standards are very convenient for measuring colors which by reason of strong fluorescence cannot be reliably analyzed by the spectrophotometer.

K. S. Campbell

Text. Research J. Jan. 1947

Effect of Heat on Fibers

The effect of heat on fibers and yarns. Emil Glücklich. *Textil-Ring* **1**, 29–33 (Sept. 1943) (through *Chem. Abstr.* **40**, 5925[6] (Oct. 10, 1946)).

A discussion of structural relationships, fiber swelling in Cu oxide-NH_3 solution, decrease of tear-resistance, change in color following the action of heat on textile fibers, change of fluorescence of fibers following exposure to heat, effect of heat on water absorption, influence of temperature on the dye-absorption properties of fibers, influence of atmospheric O on heat-treated fibers, and the significance of heat-treatment during the drying of textiles.

Text. Research J. Jan. 1947

Indigo

Indigo dyes. Karl Volz. *Allgem. Textil-Z.* **2**, 80–2 (1944) (through *Chem. Abstr.* **40**, 5922[6] (Oct. 10, 1946)).

The chemical structure of indigo, its substitution products, condensation products with phenols, etc., and various dye derivatives are discussed. The study of the chemical structure of dyes shows relationships to dyeing properties and color tone, which is of practical value to the colorist.

Text. Research J. Jan. 1947

Indigosol Dyeing

Progress in the field of indigosol dyeing. K. Dierkes. *Allgem. Tex-*

til-Z. **2**, 149–51 (1944) (through *Chem. Abstr.* **40**, 5924[3] (Oct. 10, 1946)).

A review of the structure of indigosol dyes (of which there are now about 30 types), affinity of the dye for the woolen fiber, dyeing applications and difficulties, improvements in the dyeing technique, superoxidation of some indigosol dyes, and the dyeing of rayon, staple rayon, wool, and silk.

Text. Research J. Jan. 1947

Low-Temperature Dyeing

Dyeing at low temperatures. E. Köster. *Allgem. Textil-Z.* **2**, 143–8 (1944); cf. *C.A.* **38**, 2495[8] (through *Chem. Abstr.* **40**, 5924[5] (Oct. 10, 1946)).

A survey of known practical methods of low-temperature dyeing of cellulose fibers and of the scientific basis of the dyeing phenomena involved.

Text. Research J. Jan. 1947

Package Dyeing of Rayon

Package dyeing in Germany. T. R. Smith. *Am. Dyestuff Reptr.* **35**, P413–17 (Aug. 26, 1946).

Machinery for dyeing packages, cheeses, and beams in pressure machines has not advanced as far in Germany as in the U. S.; one exception is the development of a new stainless-steel rayon-cake-dyeing machine of Obermaier closed-kier type having a capacity up to 633 lbs. In this machine the cakes, first wet out, are placed 6 to 9 high, separated by metal discs on a spindle, and the dye liquor is circulated from inside-out only; excellent results were obtained with all types of dye normally employed on rayon. The Germans used water-soluble leuco vats (*e.g.*, Indigosols) much more in package and beam dyeing than has been done in the U. S. The only really new development in dye application was the "Kupensaure," or vat-acid procedure, which was used principally for spun rayon. This process depends essentially upon controlling the dyeing rate by careful conversion, through measured additions of caustic and hydro, of the non-substantive vat acid (prepared by addition of acetic acid to the reduced concentrated stock vat) to the substantive leuco compound. Detailed formula for this dyeing process is presented. Its chief advantage is increased levelness throughout the package or beam. K. S. Campbell

Text. Research J. Jan. 1947

Wash-Fast Substantive Dyes

Some substantive dyes resistant to washing at 100°. A. I. Sokolov and A. M. Frolova. *Tekstil'naya Prom.* **6**, No. 6, 33–5 (1946) (through *Chem. Abstr.* **40**, 5923[2] (Oct. 10, 1946)).

A method of double mordanting was tested on a number of substantive dyes which included Coprantin dyes of Ciba Co., I. G. Farbenind. dyes mordanting with $CuSO_4$, and direct dyes produced by the Glavanilprom (U.S.S.R.). The dyes were mordanted with a dicyanodiamide-CH_2O condensation product (*I*), with $CuSO_4$ (*II*), or with a combination (*III*) of *I* and Cu acetate. *III* gave much better results than either *I* or *II*. The fastness to soap at 100° and to light was greatly improved by *III*. It is suggested that dyes of the type tested contain functional groups such as OH, COOH, etc., in the *o*-position to each other. This makes them apt to form chelated H bonds, and thereby internal complexes with complex-forming metals such as Cu or Cr. At the same time *I* combines with the sulfo groups of the dye. *Cf.* U. S. 2,364,725–6 (*C.A.* **39**, 3673[4]).

Text. Research J. Jan. 1947

Vat Dyes on Rayon

Special methods for dyeing with indanthrene dyes. F. Gund. *Melliand Textilber.* **24**, 399–401 (1943); cf. *C.A.* **38**, 3844[6] (through *Chem. Abstr.* **40**, 5924[4] (Oct. 10, 1946)).

A review of the fundamentals of the dyeing process, the dyeing properties of the regenerated cellulose fiber, and of the applications and limitations of the various special techniques.

Text. Research J. Jan. 1947

Sulfur Dyeing of Cotton

Dyeing cotton hanks with sulfur colors. Anon. *Am. Dyestuff Reptr.* **35**, 471–4 (Oct. 7, 1946).

Reprinted from *The Dyer and Textile Printer*, England.

K. S. Campbell

Text. Research J. Jan. 1947

Yellowing of Vat-Dyed Cloth

The yellowing of vat-dyed field-grey cloth. Otto Schaffrath. *Allgem. Textil-Z.* **2**, 148–9 (1944) (through *Chem. Abstr.* **40**, 5925[3] (Oct. 10, 1946)).

The causes of yellow streaks that may appear on prolonged exposure to the sun may be due to improper reduction, alkali, and heat in the processing of pure vat-dyed wool. Methods of avoiding this defect are explained.

Text. Research J. Jan. 1947

Decating Process

The decating process and its influence on the quality of woolen and wool-containing fabrics. J. Wieser. *Textil-Ring* **2**, 26–32 (May 1944) (through *Chem. Abstr.* **40**, 5926[4] (Oct. 10, 1946)).

Wet, dry, and steam decating and their effects are discussed.

Text. Research J. Jan. 1947

Modern Finishes

Modern textile finishes. F. W. Perry. *Am. Dyestuff Reptr.* **35**, 427–9 (Sept. 9, 1946).

An over-all picture of the textile-finishing field today. The permanent types of finishing agents are classified and their uses discussed. The difficulties caused by the present shortage of starch are outlined; the position of starch in the textile-finishing industry is explained.

K. S. Campbell

Text. Research J. Jan. 1947

Identification of Finishing Materials

A systematic scheme of identification for organic finishing agents. J. H. Skinkle. *Am. Dyestuff Reptr.* **35**, 449–52 (Sept. 23, 1946).

A scheme, similar in principle to

inorganic qualitative analysis, is presented for the identification of finishing agents on textile fabrics. The group reagents are solvents which dissolve certain classes of substances, and subsequent evaporation of the solvent shows the presence or absence of the group. Antiseptics and mildewproofing agents are omitted from the scheme for the most part because of the very small amounts normally present in fabrics. K. S. Campbell

Text. Research J. Jan. 1947

Cotton Finishing

Cotton goods finishing methods and machines. Anon. *Am. Wool and Cotton Reptr.* **60**, 15–18 (Oct. 10, 1946).

Finishing suggestion and techniques are given for cloth preparation before drying; and the operation and features of can or cylinder, cell, vacuum, festoon, and tenter driers are described. Author

Text. Research J. Jan. 1947

Shrinkproofing

Shrinkproofing resin exhausted from bath. I. G. Sanford. *Textile World* **96**, 137, 240, 244 (Sept. 1946).

Announcement of a polymerized resin emulsion known as Dur-Lana which exhausts out of the bath requiring no after-curing. Application can be made in conventional equipment, and it is said to impart shrinkage control to knitted wool fabrics, such as hosiery, producing a fabric which retains its original hand despite the addition of approximately 4 to 6% of resin. Application procedure is given.

H. J. Burnham

Text. Research J. Jan. 1947

FIBERS: YARNS: FABRICS: MECHANICAL PROCESSES

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Bast Fibers

Microscopic contribution to the flake bast problem. H. Reumuth. *Allgem. Textil-Z.* **2**, 100–14 (1944) (through *Chem. Abstr.* **40**, 5925[8] (Oct. 10, 1946)).

A detailed study of the stem morphology, systematic preparation studies of the hemp stem, bast bundles and bast cells, size of cells, gluing compounds in the cell, and components of the bast fibers as sources of certain dyeing difficulties. Many pictures (in colors) of microscopic preparations show stem anatomy, hydrolysis, dyeing problems, influence of washing, etc. 88 references.

Text. Research J. Jan. 1947

Cotton Fiber Properties

Relationships between properties of cotton fibers and percentages of wastes associated with the manufacture of carded yarns. Robert W. Webb and Howard B. Richardson. Cotton Branch, Production and Marketing Administration, U. S. Dept. of Agriculture, Washington, July 1946. 63 pp.

This report completes the 5th segment of a broad study on the relationships of cotton fiber properties to manufacturing performance and quality of manufactured products. The findings refer to percentages of picker waste, card waste, and total picker and card waste and are based on averages of data for 373 duplicate lots of case-historied American Upland cottons, representing 746 individually grown and tested cottons.

Text. Research J. Jan. 1947

Glass Fiber

The significance of the glass fiber as a textile raw material for the whole industry. Günther Satlow. *Allgem. Textil-Z.* **2**, 40–2 (1944) (through *Chem. Abstr.* **40**, 5890[8] (Oct. 10, 1946)).

An evaluation.

Text. Research J. Jan. 1947

Picker and Card Waste

Fiber waste in cotton yarn manufacturing processes. Anon. *Am. Wool and Cotton Reptr.* **60**, 13, 14 (Sept. 12, 1946).

A résumé of a report by Robert W. Webb and Howard B. Richardson of the U. S. Dept. of Agriculture on the amount and nature of waste yielded by cottons during the manufacture of cotton yarn. It was found that, of the 4 fiber properties contributing significantly to picker waste, grade is by far the most important and fiber strength the least important factor. Coefficient of length variability and percentage of mature fibers are intermediate in the order named. Of 8 separate fiber properties, only grade and coefficient of length variability show appreciable degrees of association with card waste. H. J. Burnham

Text. Research J. Jan. 1947

Effect of Environment on Fiber Properties

Environmental modification of fiber properties as a source of error in cotton experiments. D. M. Simpson and K. L. Hertel. *J. Agr. Research*, **7**, 97–111 (Aug. 1, 1946).

Seed cotton samples were obtained from 6 varieties of cotton grown at 6 locations in the Cotton Belt in 1941 and 1942. The plots received the cultivation and fertilization normally used in the various localities. At each location, 3 to 5 pickings were made at regular intervals in order that the samples might represent the production of fibers during definite and serial growth periods. Length and uniformity in length, fineness and strength of fiber were determined by the fibrograph, arealometer, and Pressley strength tester, respectively. Careful and systematic procedures were followed throughout the phases of cultivation, harvesting, ginning, storage of samples, subsampling, preparation of test specimens, and testing. The data presented in this report represent measurements of fiber properties from samples grown under a wide range of conditions. Variations in the fiber properties due to genetic and gross environmental factors are strikingly shown. Factors involving change of environment, such as location, date of opening, or year of growth, caused wide variation in the physical properties of the fiber of the several varieties. Among the upland varieties, variation

within variety due to environment frequently exceeded the differences between varieties due to hereditary influence. Without extreme care in field sampling, environmental factors may introduce bias sufficient to mask heritable qualities and vitiate conclusions drawn from accurately measured samples. Plant breeders and others interested in the study of cotton fiber properties, therefore, may well be forewarned that samples for fiber study must be taken with great care, if minor genetic differences are to be detected, as differences between samples in fiber properties may be due as much to location or date of picking as to variety or genetic strain. The broad implication of the findings covered in this report, while not so stated by the authors, is that cotton spinners, merchants and growers also should be forewarned that noticeable variations in cotton fiber properties and resultant spinning quality can exist even within a well-established and properly controlled single-variety-cotton-production community throughout the season of a given crop year, between different organized cotton communities planted to the same variety in a given crop year, and for the same community planted to the same variety in different crop years. The desirability of this further forewarning is emphasized by results obtained by others with such one-variety and organized-community cottons under test in fiber and spinning laboratories as well as in commercial textile plants.

Text. Research J. Jan. 1947 R. W. Webb

Cellulose Ether Sizes

Increasing the wear of cotton fabrics. Wash-resistant size. A. A. Kop'ev. *Tekstil'naya Prom.* 6, No. 2, 28–30 (1946) (through *Chem. Abstr.* **40**, 5927[5] (Oct. 10, 1946)).

The preparation, use, and advantages of permanent, alkali-soluble cellulose ether sizes are discussed. The one prepared by NIIV (Synthetic Fibers Research Institute) closely resembles Tylose.

Text. Research J. Jan. 1947

Rayon in Tires

Some technical aspects of the use of high-tenacity viscose-process rayon in tires. W. Wycliffe Owen. *India Rubber World* **114**, 515–20 (1946) (through *Chem. Abstr.* **40**, 6287[8] (Oct. 20, 1946)).

The successful development of rayon cord for tires and the construction of such tires are described and illustrated. The relatively high tenacity per unit gage of rayon cord makes possible the manufacture of truck, bus, airplane, and earth-mover tires which are thinner, lighter in weight, have higher carcass strength, higher resistance to impact bruising, and much higher strength at elevated temperatures than would otherwise be possible. Retreading can be carried out a greater number of times. Reduction in thickness of carcass is of 2-fold advantage, because: (1) approximately 6% less rubber is required than for a tire of equivalent strength reinforced with cotton cord, and (2) heat developed within a tire carcass by flexing has a shorter distance to travel and is dissipated more rapidly so that internal tire temperatures are appreciably lower. Tests have indicated that each $\frac{1}{32}$-in. increase in tire thickness results in a rise of temperature of 5°F. Hence the likelihood of carcass failure by excessive heating under severe conditions of service is lessened and tread life is increased.

Text. Research J. Jan. 1947

Cleaning Uniform Cloth

Comparative tests on the wet-washing and chemical dry-cleaning of uniform cloth and woolen goods. Viertel. *Allgem. Textil-Z.* **2**, 276–9 (1944) (through *Chem. Abstr.* **40**, 5927[9] (Oct. 10, 1946)).

The development of neutral washing agents of good resistance to hardness formers in water and of good wetting, emulsifying, dispersing, and cleaning properties has made it possible to wet-wash woolen goods in a neutral or faintly acid bath without causing greater fiber damages than are caused by chemical dry-cleaning. Brief chemical dry-cleaning followed by modern wet-washing is a good procedure for woolen goods. The results of cleaning tests are reported.

Text. Research J. Jan. 1947

Twist-Setting

Dielectric heating cuts twist-setting and drying time. C. N. Batsel. *Textile World* **96**, 139, 141, 216, 220, 224, 227 (Sept. 1946).

A description of the use of high-frequency heating as a means of setting twist in rayon yarns and drying rayon cakes and sized nylon. It is said to offer its greatest advantage when treating material in packages because of its ability to heat or dry uniformly regardless of the size of the package, permitting the use of packages above the size limits sometimes imposed by other methods. H. J. Burnham

Text. Research J. Jan. 1947

Fibrous Proteins

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A symposium on fibrous proteins was presented by the Society of Dyers and Colourists at the University of Leeds in May, 1946. At this symposium 29 papers were delivered by well-known authorities in various divisions of the general field. Each paper was followed by a general discussion. The entire proceedings of the symposium have been published in one volume by the Society of Dyers and Colourists, whose address is The University, Leeds, England.

The authors' summaries of the papers are given below. Anyone interested may obtain copies of the proceedings from the Society.

Structure of Proteins

A new approach to the problem of the structure of proteins. An investigation of a partial hydrolysate of wool. A. J. P. Martin. *Fibrous Proteins*, 1–4.

The examination of a partial acid hydrolysate of wool by ionophoresis and partition chromatography has shown the presence of a large number of dipeptides containing aspartic

and glutamic acids in the negatively charged fraction. These findings are inconsistent with the Bergmann-Niemann hypothesis and with the structure for keratin recently advanced by Astbury. 12 references. Author

Text. Research J. Jan. 1947

X-Ray Fiber Analysis

Modern technique in the x-ray structure analysis of fibers. I. MacArthur. *Fibrous Proteins*, 5–14.

Fibers are a class of imperfectly ordered solids formed of macromolecules, usually long-chain high polymers; their structure analysis, *e.g.*, by x-ray methods, involves specialized problems, both of registration and interpretation. As compared with crystal analysis, a greater proportion of time is advantageously spent on the experimental side, the material being subjected to varied conditions; owing to the high incidence of distortion, faulting, polymorphism, etc., interpretations also need special care; while secondary structure, so important in practical problems of elastic and mechanical properties, demands specialized technique. In brief, fiber structural problems usually require both breadth and precision of x-ray methods, with the complementary use of adequate ancillary physicochemical techniques and background, and analysis based more on first principles. On this basis, modern technique applicable to the production and analysis of fiber x-radiograms [*sic*] is summarized, and some of the more fundamental fiber problems ahead are briefly discussed. 203 references. Author

Text. Research J. Jan. 1947

Structure of Epidermal Protein

The structure of epidermal protein. K. M. Rudall. *Fibrous Proteins*, 15–23.

Fibrous proteins showing the α type of structure (as in keratin, myosin, and fibrinogen) may be expected to occur in any body cell. Properties of the chief intracellular protein of the mammalian epidermis are compared with those of a characteristic protein extracted from the growing layers of the epidermis in 50% urea. The molecular changes during the supercontraction of labile α-type proteins (epidermin, myosin, fibrinogen, fibrin) are described. The molecular configuration of the supercontracted state corresponds to extended chains folded at right angles to the fiber axis and the pattern is termed the cross β-pattern ($X\beta$) to distinguish it from the normal β-keratin pattern ($||\beta$). The cycles $\alpha \rightarrow ||\beta \rightarrow \alpha$ and $\alpha \rightarrow X\beta \rightarrow \alpha$ have been demonstrated leading to the proposition of a complete cycle $\alpha \rightarrow X\beta \rightarrow \alpha \rightarrow ||\beta \rightarrow \alpha$. New principles concerning the nature of "permanent set" in extended polypeptide chains are raised. Comments are made on chain-folding in corpuscular proteins. 29 references. Author

Text. Research J. Jan. 1947

Rubberlike Properties of Proteins

The rubberlike condition of the fibers of animal skin. Dorothy Jordan Lloyd and Marjorie Garrod. *Fibrous Proteins*, 24–9.

The effect of temperature on the load-extension curves of (1) elastin in water, (2) silk after axial contraction in formic acid, (3) collagen after axial contraction in formic acid, and (4) keratin (horsehair) in formic acid, suggests that the "rubberiness" of protein fibers (when in the rubberlike condition) depends partly on entropy effects in the configuration of the polymeric backbone. When the ratio of polar groups in the side chains per unit length of backbone is low, this entropy effect is marked, but with increasing ratio of side-chain polar groups the entropy effect diminishes and finally cannot be demonstrated. The rubberiness of protein fibers in the absence of entropy effects is ascribed to mutual attractions of the polar side chains. Elastin forms a fiber in which rubberiness is almost entirely due to entropy effects in the backbone; keratin forms one in which rubberiness is mainly due to the mutual attraction of polar side chains. Silk and collagen appear to be intermediate. A protein fiber cannot show rubbery properties unless the polymeric backbone is in a condition of irregular (elastin) or regular (keratin) looping, i.e., with less over-all length per molecule than at full extension. 22 references. Authors

Text. Research J. Jan. 1947

Nonsolvent Water in Hides

The "nonsolvent" water in hides. H. Eilers and J. W. A. Labout. *Fibrous Proteins*, 30–8.

The quantity of "bound" water found in colloidal substances such as collagen and gelatin varies with the method chosen for the determination. In the present investigation the quantity of water in collagen "not dissolving nonelectrolytes" was determined with different auxiliary materials, giving different values for this quantity. The hypothesis is defended that the "water not dissolving nonelectrolytes" consists of two parts, *viz.*, (1) water actually bound to the colloid (20% approx.) and (2) water in cavities of the colloidal substance too small to permit the penetration of larger molecules of the organic auxiliary substance (in measurements with saccharose as auxiliary material, this also amounts to 20% approx.). The quantity of "water not dissolving nonelectrolytes" was determined in pieces of hide in different baths. It is fairly constant in baths of pH < 10 and increases with higher pH. It is, moreover, dependent on the other ions present in the medium. The quantity of "nonsolvent" water is scarcely influenced by the treatment of the hide in the stages before the actual tanning, provided that determinations are made in the same bath. 44 references. Authors

Text. Research J. Jan. 1947

Cystine of Wool

The division of the combined cystine of wool into four subfractions differing in chemical reactivity. H. Phillips. *Fibrous Proteins*. 39–49.

The combined cystine of wool can be divided into 4 subfractions, termed *A*, *B*, *C*, and *D*, differing, under certain experimental condi-

tions, in their rate and mode of reaction with sodium bisulfite, alkalis, formaldehyde, and thiolacetic acid. The thiol groups obtained by the reduction of subfraction *A* also differ in reactivity towards formaldehyde, methylene dibromide, and possibly oxygen from the thiol groups derived from subfraction *B*. These differences in reactivity may arise from differences in side-chain environments, fraction $(A+B)$ being associated with polar side chains, whereas fraction $(C+D)$ is associated with nonpolar side chains. Some experiments with wool of which the free carboxyl groups had been esterified suggest that the side-chain environment of subfraction *A* contains salt-linkages which tend to prevent the separation of the sulfur atoms when the cross-linkages of this subfraction are reduced. Subfraction *B*, on the other hand, may be associated with amide side chains that do not resist the separation of the sulfur atoms of the reduced disulfide groups. Fraction $(A+B)$ of the combined cystine of wool appears to be more closely concerned in the physical properties of wool than is fraction $(C+D)$; subfraction *A* appears to play the most prominent part of all the 4 subfractions. The cross-linkages of subfraction *A* and the salt-linkages mutually support one another; swelling and hydration initiated by salt-linkages are restricted by the intact cross-linkages of subfraction *A*. When these are broken, the restriction and the strained intermolecular conditions set up by swelling and hydration, coupled with thermal agitation, result in the breakdown of hydrogen bonding. In the unextended fiber, this enables supercontraction to take place. It appears likely that the strained hydrogen bonding of an extended fiber can be overcome by thermal agitation of the main chains without disulfide breakdown. When the extended and relaxed fiber is released it will supercontract; if the fiber is maintained extended, the renewal of hydrogen bonding will cause the fiber to set. The permanency of this set can be increased by the conversion of the disulfide cross-linkages of subfraction *A* and possibly subfraction *B* into lanthionine cross-linkages. These reimpose restrictions on the swelling and hydration initiated by salt-linkages and so impart stability to the molecular structure. 34 references. Author

Text. Research J. Jan. 1947

Supercontraction in Keratin

The supercontraction of animal fibers. C. S. Whewell and H. J. Woods. *Fibrous Proteins*, 50–7.

The physicochemical methods of producing supercontraction in keratin are reviewed and discussed in connection with the use of the phenomenon as a test for side-chain modification. Besides the more familiar types of supercontraction induced by steaming relaxed fibers or by boiling in various reagents, a reversible supercontraction phenomenon is described and its relation to the general theory of main-chain folding following side-chain breakdown is discussed. 22 references.

Text. Research J. Jan. 1947 Authors

Chemistry of Hair

The chemistry of animal hair. J. L. Stoves. *Fibrous Proteins*, 58–66.

Changes in the physicochemical properties (elasticity and supercontraction) of human hair have been used to examine the action of alkalis, reducing agents, oxidizing agents, formaldehyde, and benzoquinone on keratin fibers. The effect of alkalis, reducing agents, oxidizing agents, trypsin, and dyes on cross sections of various animal hairs is also recorded, and the chemistry of the reactions discussed in terms of the fission and synthesis of cross-linkages. 41 references.

Text. Research J. Jan. 1947 Author

Microbiology of Protein Fibers

Problems in the microbiology of protein fibers. E. Race. *Fibrous Proteins*, 67–85.

The types of micro-organisms which can attack and degrade protein fibers and the conditions appertaining to, and the incidence of, bacterial proteolysis are described. The wool-degrading activities of a number of bacteria identified as being present in degraded wool have been examined, and a comparison of the effectiveness of bactericides in combating attack by these organisms has been made; in general, the Gram-negative organisms (e.g., *Pseudomonas* spp. and *Proteus vulgaris*) appear more resistant to the action of bactericides than the Gram-positive *Bacilli*. The most important factors which influence bactericidal activity and the modes of action of bactericides are discussed. Of the bactericides tested, outstanding in efficiency are phenyl mercuric acetate, copper naphthenate, and cuprammonium hydroxide; because of the inapplicability of the two first-named compounds in certain cases, attention has been directed to the cuprammonium treatment of wool and attempts made to improve its bactericidal and fungicidal efficiency. It is shown that when copper chromate, applied to wool from an ammoniacal solution in the presence of a suitable dispersing agent, is hydrolyzed with water, the copper is retained in particulate form in the gross pores of the fiber, and quantitative tests indicate that the bactericidal and fungicidal activities of this process are superior to those of a normal cuprammonium process. The effectiveness of a proofing agent appears to be determined by two main factors, *viz.*, (*a*) the inherent toxicity of the agent and (*b*) the availability of the toxic principle. While (*a*) has a predetermined value, (*b*) depends on the method of application which is adopted, and the results suggest that the availability factor is not dependent solely on the solubility in water of the toxic principle. It is suggested that, in the case of particulate deposition of a copper compound inside the wool fiber, the actual solubility of the compound may be less than in the case of a copper compound chemically associated with the keratin complex, although, because of occlusion on the surface of the bacterial cells, the effective concentration of the compound in the immediate vicinity of the micro-organism may be greater. 46 references. Author

Text. Research J. Jan. 1947

Water Absorption of Keratin

Water absorption of keratin. A. B. D. Cassie. *Fibrous Proteins*, 86–95.

The essential requirements of a theory of water absorption by keratin are discussed, and it is shown that the sorption isotherm and measured heat effects require the absorption at high regains to be due to an increase of entropy. This eliminates capillary condensation and potential theories which ascribe absorption to a decrease in the heat content of the system without increase of entropy. The effect of swelling energy on the sorption isotherm is described, and a stress-free isotherm is given. The stress-free isotherm is analyzed by means of an appropriate multimolecular absorption theory. The analysis indicates that the water-attracting groups in keratin are —CO—, and it gives the energy of bonding of the water to the groups as 6.6 kg. cal. per mole. The minimum swelling of wool in water, which is observed at 37°C, is used to calculate the differential swelling energy at saturation regain; it is 550 g. cal. per mole, which agrees to within the limit of experimental error with the value obtained from the measured swelling and elastic constants of keratin. It is shown that the increase in entropy due to absorption of water requires the sorbed water to be present as discrete clusters. This conclusion is consistent with the water-repellency of cut horn keratin surfaces. 28 references. Author

Text. Research J. Jan. 1947

Adsorption by Wool

A criticism of some theories of multimolecular adsorption applied to wool. G. A. Gilbert. *Fibrous Proteins*, 96–9.

Three theories are discussed which have been applied to the adsorption of water vapor by wool, and it is suggested that they have faults which prevent their giving a true picture of the system. 11 references. Author

Text. Research J. Jan. 1947

Macromolecular Spreading at Interface

The orientation of macromolecules by interfaces. D. J. Crisp. *Fibrous Proteins*, 100–4.

Many linear macromolecules may be spread at an air-water or an oil-water interface. The factors which govern the character and stability of the film are (*a*) the cohesion of the molecules tending to cause collapse into the 3-dimensional state, and (*b*) the free-energy lowering when the film is present at the interface. The free energy lowering per molecule will be large when the molecule contains many segments, thus accounting for the stability at an interface even of soluble macromolecules. Long molecules do not always lie flat; when compressed, the film normally acquires submolecular regions of 3-dimensional phase, the "overfilm." Films may be deposited from the water surface onto slides as multilayers, the possibility of deposition being dependent on the nature of the surface of the film, the readiness with which water peels off the slide on withdrawal, and the rate of deposition. Multilayers have a normal density and retain the orientation acquired at the interface. Fibers drawn off a compressed film have mechanical properties analogous to those of the film, but these are lost when the fibers are dried. 13 references.

Author

Text. Research J. Jan. 1947

Spreading Technique on Synthetic Proteins

The use of a spreading method technique in research on artificial protein fibers. L. Maaskant. *Fibrous Proteins*, 105–7.

By using the spreading method technique, the resistance of artificial protein fibers to dilute alkaline and acid solutions can be expressed numerically. The importance of the method in relation to research on these fibers is demonstrated. 3 references. Author

Text. Research J. Jan. 1947

Interpretation of Dye Distribution

Interpretation of the distribution of sorbed dye and other molecules in proteins and plastics. R. M. Barrer. *Fibrous Proteins*, 108–15.

Equilibria between dye molecules and the sorbing medium should be governed by principles similar to those controlling sorption of simpler molecules in such colloids. In neither case are the details understood and, especially in the sorption of dyes, the art has outstripped its scientific interpretation. The sorption phenomenon has kinetic and equilibrium aspects, and the former will be especially under review. Much of the obscurity in the past has resulted from the mathematical complexity of the equations of diffusion kinetics. Moreover, it is still uncertain, as is shown in this paper, what fundamental differential equation should be applied. 4 differential diffusion equations are given and their treatment described. 18 references. Author

Text. Research J. Jan. 1947

Combination of Wool with Acids

The combination of wool with acids and acid dyes. J. B. Speakman and G. H. Elliott. *Fibrous Proteins*, 166–28.

During the past 30 years, a large body of evidence has been accumulated to show that combination of wool with acid dyes is stoichiometric in character, *i.e.*, that the combining capacity of wool for acid dyes is the same as for simple acids, *e.g.*, hydrochloric acid. Astbury and Dawson's x-ray examination of dyed wools, however, gave results in sharp conflict with the chemical evidence. They found that wool dyed to saturation with Crystal Ponceau gave a normal α-photograph, indicating that the dye had not penetrated the crystalline phase of the fibers; and, unlike simple organic acids, dye-acids were incapable of delaying or preventing setting of the crystalline phase of stretched fibers in steam, as would be expected if this phase were inaccessible to dye-acids. In an attempt to reconcile

the two sets of results, the physical, chemical, and x-ray evidence concerning the mode of combination of wool with acid dyes has been reexamined. 24 references.

Text. Research J. Jan. 1947 Authors

Damaged Wools

Some physicochemical properties of damaged wools. D. R. Lemin and T. Vickerstaff. *Fibrous Proteins*, 129–41.

Physicochemical studies have been carried out on normal wool and wool which has been subjected to either alkali, strong sulfuric acid, hydrogen peroxide, or chlorine. Acid and base binding, rates of dyeing from dye baths of constant composition, and affinity determinations have been carried out on the treated samples. The results indicate that all the damaged wools dye more heavily than normal wool during the initial stages of dyeing under normal acid dye-bath conditions because of greater swelling, probably owing to disulfide bond breakdown, but if dyeing is continued sufficiently long the depth of shade should be equal on chlorinated, alkali-damaged, and normal wool because these 3 types of wool have equal affinity and an equal number of sites available for dye. A weaker shade is to be expected on carbonized wool because there are fewer sites available for dye, although it has the same affinity for dye as normal wool. In the case of peroxide-bleached wool the shade should be much weaker, because both the affinity and the number of sites available are reduced as compared with normal wool. 14 references. Author

Text. Research J. Jan. 1947

Action of Metallic Salts on Proteins

Colored metal complexes of keratin and fibroin. B. Nilssen. *Fibrous Proteins*, 142–3.

The complex derivatives formed by the action of nitrites and metallic salts on tyrosine-containing protein fibers have been studied. A structure for the compounds is suggested, and the possibility of preparing strongly colored complexes is discussed. 1 reference. Author

Text. Research J. Jan. 1947

Structure of Silk Fibroin

The structure of silk fibroin and its bearing on fibrous proteins. D. Coleman and F. O. Howitt. *Fibrous Proteins*, 144–52.

Certain aspects of the study of protein structure are discussed with reference to the comparatively simple structure of the silk fibroin molecule. The contents of certain amino acids in fibroin are determined—the values obtained are histidine 0.40–0.45%, serine 12.6%, threonine 1.5%, tyrosine 10.6%, and proline 1.5%. Hydroxyproline appears to be absent, but the presence of small amounts of some hydroxyamino acid other than serine or threonine is indicated. The mean residue weight of fibroin is determined, one method for this determination being the analysis of the cupri-ethylenediamine complex of fibroin. The value of 78.0 obtained, together with the most acceptable data for the amino-acid distribution, indicates that the amino acids so far unidentified have a mean molecular weight of 136. Evidence is presented that fibroin contains little or no amide-nitrogen. Methods at present in use for the determination of amide-nitrogen, which give a content of 1–2%, are considered to be untrustworthy. Fibroin dissolved in cupri-ethylenediamine gives, on neutralization and dialysis of the resulting solution, a water-soluble protein, the characteristic properties of which are described. It is shown that this conversion is attended by little or no degradation of the protein. The water-soluble protein spontaneously sets to a gel of insoluble protein on keeping at room temperature for a few days, while it reverts to the insoluble form when precipitated from solution by any of the known protein-precipitating agents. The aqueous preparations of fibroin contain two forms of the protein, one of which is considered to be the protein in a truly water-soluble or globular state and the other the protein in a dispersed state. Factors responsible for the solubilization process are investigated and data given for the molecular weight, titration values, optical rotation, ultra-violet absorption spectra, reducing activity, viscosity, and tryptic hydrolysis of both water-soluble and dispersed forms. The preparation and properties of films and filaments of fibroin are described. Films of fibroin are prepared that are water-soluble and, on stretching, show strain birefringence, acquire considerable tensile strength, and become completely insoluble in water. It is considered that the water-soluble form of fibroin is closely similar to, or identical with, the native protein as it occurs in the silk gland and that the insoluble form, either as the natural silk filament, the fibroin dispersed in solution, or the precipitated material from water-soluble preparations, is the denatured protein. The denaturation of fibroin is discussed on the basis that denaturation is essentially an unfolding of a coiled long-chain molecule, and the view is advanced that the amino acids in the fibroin molecule are specifically arranged to form "molecular hinges" by which such a folding may occur. The implications arising from the study of fibroin are discussed with reference to other natural fiber-forming proteins and to the general behavior of protein and polypeptide chains as macromolecules. 41 references.

Text. Research J. Jan. 1947 Authors

Isoelectric Point of Fibroin

The isoelectric point of silk fibroin. T. H. Morton. *Fibrous Proteins*, 153–5.

Values of the isoelectric point (I.E.P.) of mulberry silk fibroin given in the literature range from pH 2 to pH 6. A new determination of the bulk I.E.P. of fibroin based on an ion-exchange method has shown that the true value depends on the ionic strength of solution in which it is determined. I.E.P.'s of mulberry silk fibroin from various sources are constant within 0.1 pH unit. For a Japanese silk the values obtained were 4.74, 4.55, and 4.45 in 0.01*M*-, 0.1*M*-, and *M*-sodium chloride, respectively.

For textile-processing purposes the I.E.P. of fibroin may be taken as pH 4.7, approximately. 13 references. Author

Text. Research J. Jan. 1947

Silk Finishing

Equilibrium between silk and aqueous solutions: Internal reaction of silk fibroin. T. H. Morton. *Fibrous Proteins*, 155–9.

The water extract of silk may be more alkaline than a softened water used in finishing the silk. This effect is due to an ionic equilibrium of the Donnan type. Silk fibroin has a "proper reaction" or internal pH value which, for approximately neutral silks, is much lower than the pH value of the finishing bath. The magnitude of this difference depends on the ionic strength of the aqueous solution, vanishing for high salt concentrations. Silk is best characterized chemically by its proper reaction. The consequences of ionic equilibrium have been treated theoretically, and it is found that the theoretically expected differences are confirmed experimentally. The relation between proper reaction and combined alkali (sodium hydroxide) in fibroin has been measured. Base-exchange equilibria of the zeolite type occur with silk; calcium ions are perferentially absorbed by sodium fibroinate. This effect is common to all ionized textile fibers. The implications of ionic equilibria in the finishing of silk are indicated. 2 references. Author

Text. Research J. Jan. 1947

Treatment of Casein with Metallic Salts

The improvement of the properties of casein fibers by treatment with metallic salts. F. Happey and R. L. Wormell. *Fibrous Proteins*, 160–6.

Increase in the wet strengths of Fibrolane yarns treated with salts of chromium, zinc, cadmium, and mercury compared with those of normal material has been found. A decrease in water imbibition has also been noted. X-ray photographs show that the main portion of the absorbed metal is probably attached to the side chains of the protein molecules; but in the case of cadmium and zinc using basic unfiltered solutions, a phase of metallic salt is absorbed in the interstices of the fibers. With filtered solutions these precipitates are avoided and considerable economy of metal is obtained, with no apparent decrease in tenacity of the wet fibers. When basic zinc chloride is absorbed, it is orientated so as to give a "fiber photograph" of the salt with its most intense reflection along the equator of the casein diagram. This orientation is correlated with the high orientation of the casein agglomerates which give rise to reflections on the equator near the center of the photograph. In fibers treated with basic cadmium acetate a precipitate of cadmium carbonate is found in the finished product, but with filtered solutions this additional phase is absent. Chromium and mercury appear to be completely absorbed, giving no crystalline precipitate which can be seen on the x-ray diagram. From a consideration of the relationship between the absorption of metal and the physical properties of the fibers, zinc is probably the most satisfactory metal to use. It is economical on account of its relatively low atomic weight and causes no discoloration of the fibers, but it is necessary to avoid deposition of basic zinc chloride in the interstices of the casein. A preliminary theoretical survey of the possible positions of the absorbed metal on the acidic side chains of the protein, or coordinated with the basic amino groups of these side chains, is outlined. 12 references. Authors

Text. Research J. Jan. 1947

Dyeing of Casein

The dyeing of casein fiber. C. P. Tattersfield. *Fibrous Proteins*, 167–72.

The dyeing of Fibrolane, alone and mixed with wool or Fibro, is revised. Some of the dyeing variables, *e.g.*, time, temperature, and pH, as well as the individual character of the dyes, are considered and comparisons are drawn with the dyeing of wool and Fibro. While particular attention is directed to the application of acid, Neolan, chrome, and direct dyes, the less important types, *viz.*, sulfur, vat, and cellulose acetate rayon dyes, are also mentioned. 10 references. Author

Text. Research J. Jan. 1947

Vegetable Globulins

The extrusion of filaments from solutions of vegetable globulins. R. H. K. Thomson. *Fibrous Proteins*, 173–7.

The reactions between selected vegetable globulins (ground nut, soya bean, or lupin seed) and caustic soda and water have been studied for reaction times of 20 hrs. at 20°C. The reaction with ground nut globulin has been studied at 20°–70°C and for 10–60 hrs., reaction time. The physical nature of the reaction product, sol or gel, has been recorded. Under the conditions of the Ardil process the ability of these systems to be extruded to form filaments was restricted to the parts of the system where the reaction product changes from sol to gel. 4 references. Author

Text. Research J. Jan. 1947

Felting

Some practical and theoretical observations on felting. M. R. Freney. *Fibrous Proteins*, 178–92.

The subject of felting is critically reviewed and difficulties in correlating results of various workers are shown to arise from the different methods used to promote felting. Factors concerned in felting are discussed, including fiber organization, type of applied friction, wool quality, fiber length, blending, tendency to curl, temperature, pH, and liquor penetration. The author considers that the tendency of fibers to twist is a factor which plays a part in felting. The subject of scaliness is discussed in some detail and the various methods used to determine the directional frictional effect (D.F.E.) are outlined. A review of theories on the mechanism of felting is followed by an outline of the different methods for producing unshrinkable wool and their effect on fiber scaliness. The chemical effects of the unshrinkable reagents are reviewed, and it is

considered that some penetration of the fiber is necessary. The need for absolute measurements of fiber scaliness, rather than indirect determination of D.F.E., is stressed. 78 references. Author

Text. Research J. Jan. 1947

Action of Fluorides on Wool

The action of fluorine and fluorides on wool. R. F. Hudson and P. Alexander. *Fibrous Proteins*, 193–8.

Results of the direct fluorination of wool at various humidities and concentrations are given, and the optimum conditions for producing maximum unshrinkability stated. It is considered that the action is confined totally to the cystine linkage, as a volatile sulfur fluoride is the only product of the reaction on mild treatments. This is confirmed by the fact that wool previously treated with dilute aqueous sodium hydroxide for many hours, in order to replace the disulfide linkages by more stable cross-links, has its felting powers unaffected by treatment with fluorine. Analyses employing cobaltic fluoride as the source of fluorine have shown that a minimum of 0.5% fluorine on the weight of wool is necessary to produce nonfelting wool. In most cases 0.5–1% is required. Whereas disulfide-bond breakdown is the cause of the antifelting action of fluorine, it is considered that a completely different mechanism, probably main-chain hydrolysis, is responsible for the limited antifelting action of aqueous hydrogen fluoride. 15 references. Authors

Text. Research J. Jan. 1947

Antishrink Treatments

Effectiveness of oxidation antishrink treatments to acid and alkali milling. P. Alexander. *Fibrous Proteins*, 199–202.

Wool treated with a series of oxidizing agents known to produce unshrinkability was milled in acid and alkaline solutions. All the reagents render wool unshrinkable towards alkali milling, but they can be divided into 3 categories, depending on their behavior during acid milling, *viz.*, (1) agents producing very little reduction in shrinkage, (2) those producing partial reduction in shrinkage, and (3) those producing total unshrinkability. In addition, if a given fabric is treated with a member of the first group of reagents and alkali-milled, it is unshrinkable, but subsequent acid milling felts it considerably. It is difficult to interpret these results in the light of present theories on antishrink action. 19 references.

Text. Research J. Jan. 1947 Author

Natural and Synthetic Proteins

Natural and synthetic protein fibers. M. Harris and A. E. Brown. *Fibrous Proteins*, 203–6.

The structures of wool and silk and the dependence of some mechanical properties of these fibers on their structures are analyzed. On the basis of this analysis it is shown that there are two distinct protein fiber models, the "wool model" and the "silk model." A discussion of the present synthetic protein fibers in terms of these models is presented. 22 references. Authors

Text. Research J. Jan. 1947

Effect of Nutrition on Wool Production

Nutrition and wool production. H. R. Marston. *Fibrous Proteins*, 207–14.

There is little exact knowledge of the physiological events involved in the production of the highly keratinized, cutaneous outgrowths. During experimental study of the influence of nutrition on wool production by merino sheep a number of facts have been established which concern the process of keratinization. Those which seem cogent to the subject of this Symposium are discussed briefly. The full experimental bases of these investigations will be published elsewhere—in this discussion the data are limited to those necessary to illustrate the argument. 71 references. Author

Text. Research J. Jan. 1947

Shrinkage Control

The shrinkage control of wool. J. R. Dudley and J. E. Lynn. *Fibrous Proteins*, 215–20.

The preparation, properties, and structure of melamine are discussed, and the nature of the condensation products of melamine and formaldehyde is described with reference to the various factors involved in the reaction. Current theories regarding the mechanism of the formation of resinous condensation products from melamine and formaldehyde are presented, and the type of resin intermediate required for the treatment of wool to achieve shrinkage control is described. Comparisons are made of the use of different types of resins for the treatment of wool, and data from laboratory and mill runs are presented to show the effectiveness of the melamine resin for controlling shrinkage. The usual methods of application are described, and various factors which affect the treatment are discussed. 28 references. Authors

Text. Research J. Jan. 1947

O. T. S. REPORTS*

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Dyes and Color Applications

Supplementary report on German dyes. (Suppl. to "The development of new dyes and color application processes in Germany and Italy during World War II.") (QM Textile Series Rept. 18.) M. L. Crossley and Miles A. Dahlen. PB 39562, June 1946; 57 pp.; microfilm, $2.00—enlargement print, $4.00 (through *Bib. Sci. and Ind. Reports* **3**, 1 (Oct. 4, 1946)).

This is a supplement to the report on German dye developments (see PB 31004, *Bibliography* **2**, 313, originating from the Office of The Quartermaster General). The actual manufacturing processes, as employed by the I. G. Farbenindustrie, A. G., for a total of approximately 50 dyes are presented. Usually, the composition of the charge, the procedure and appa-

*Copies of these reports may be obtained from the Office of Technical Services, Department of Commerce, Washington 25, D. C. Orders should be accompanied by check or money order payable to the Treasurer of the United States.

ratus, and the use of the product are described. The dyes represented are those of the indanthrene, "immedial" and sulfur type. Some of the material contained in this document appears in its original German version on the 8 microfilm reels containing PB 32532 to 32539.
Text. Research J. Jan. 1947

Dye Manufacture

Dyestuffs, intermediates, textile auxiliaries, polymers, and pharmaceuticals. (Abstracts of I. G. Farbenindustrie manufacturing processes.) (Index and abstracts of microfilms, PB 32532–32539.) (QM Textile Series Rept. 19.) Joseph H. Trepagnier and Frederic T. Weishut. PB 32510, May 1946; 240 pp.; microfilm, $5.00—enlargement print, $16.00 (through *Bib. Sci. and Ind. Reports* **3**, 1 (Oct. 4, 1946)).

In the investigation of technical and scientific progress in Germany during the war it was expected that many new developments would be encountered in the field of dye chemistry and color application. Two investigators from the Office of The Quartermaster General (M. A. Dahlen and M. L. Crossley) furnished a report entitled "The development of new dyes and color application processes in Germany and Italy during World War II" which has been made available under PB 31004 (see *Bibliography* **2**, 313). In addition to the material contained in this report and a subsequent supplement (see PB 39562), files containing the actual manufacturing procedures used by the I. G. Farbenindustrie in the manufacture of dyes, intermediates, textile aids, pharmaceuticals, etc., were unearthed. These papers were microfilmed in Germany and rearranged and abstracted at the Office of The Quartermaster General by the authors of this document. The processes, numbering over 1,500, are reproduced on 8 reels of microfilm (see PB 32532 to 32539); their abstracts, consisting usually of the name of the compound and an enumeration of the starting materials, appear in this report. The abstracts on dyes are arranged by chemical classes; the others, for the sake of simplicity, are presented as they occur on the film. Legibility of the films differs widely, since the documents were reproduced under difficult conditions. In some cases, the pages concerning several processes are intermingled. In this connection, it is suggested by the authors that certain steps of rearranging and editing be undertaken to make this document even more useful and clear. A description of the content and condition of one of the eight microfilm reels appears below. Abstracts of the individual processes will be made available under separate PB numbers at a later date.
Text. Research J. Jan. 1947

Dyestuffs. (For index and abstracts see PB 32510.) (QM Textile Series Rept. 19, Reel I.) I. G. Farbenindustrie, A. G. PB 32532, n.d.; 1,030 pp.; microfilm, $6.00—enlargement print, $103.00 (through *Bib. Sci. and Ind. Reports* **3**, 1 (Oct. 4, 1946)).

This film contains processes for the batch manufacture of vat colors and related products, azo colors, triphenylmethane dyes and related products, sulfur colors, and miscellaneous colors. In most instances composition of the charge, control of the process, yield, apparatus, characteristics, chemical formula, and use of the product are given, together with a step-by-step outline of the process. Most of the items are complete and the pages are intact, in order, and legible. In German.
Text. Research J. Jan. 1947

Strengthening Silks

Prof. Walter Scheele, Celle (Research reports on increasing the tensile strength of silks with synthetic resins). (ALSOS: RFR 61.) Germany. Reichsforschungsrat. PB 13166, July 1942–July 1944; 101 pp.; microfilm, $1.50—photostat, $7.00 (through *Bib. Sci. and Ind. Reports* **3**, 56 (Oct. 4, 1946)).

This is a report on research done to develop a method of increasing the strength of natural and artificial silks by impregnation with resins. The basic promise of the work is that the molecules forming the silk orient themselves in the fiber to form tiny capillaries. In order to strengthen these capillary fibers by the use of synthetic resins, it is necessary that the resin molecule be of smaller size than the capillary, in order that the resin may penetrate into rather than be adsorbed on the fiber. If this could be accomplished, the resin would be fixed in the fiber. Experimental work is described on the production of a resin of small molecular size. Further work was done on the repair of torn parachutes. A method was worked out whereby it is possible to fasten strips of parachute cloth together by means of a plastic material size used as an adhesive, the joint being stronger than the cloth used. It is thus possible to do away with the sewing of parachutes. A few financial and administrative matters are included in this file. In German.
Text. Research J. Jan. 1947

Textile Education

Textile education in Germany. (Text of PB 3892, with foreword, chart, and list of schools added.) (FIAT Final Rept. 542.) William D. Fales and others. PB 33104, Nov. 1945; 39 pp.; microfilm, $1.00—photostat, $3.00 (through *Bib. Sci. and Ind. Reports* **2**, 994 (Sept. 27, 1946)).

This report contains the text of PB 3892 (*Bibliography* **2**, 150) with the addition of a foreword by William D. Fales, a chart showing the plan of organization of a German textile school, and a list of 59 German textile schools, giving location and nature of curriculum.
Text. Research J. Jan. 1947

MISCELLANEOUS

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A.A.T.C.C. Sub-Committee Reports

145th Research Committee meeting. *Am. Dyestuff Reptr.* **35**, 140–8, 163–4 (Mar. 25, 1946).

The following reports of the research sub-committees of the A.A.T.C.C. are given: committees on insect

pests, detergency, mildew proofing, accelerated ageing of cotton, wash-fastness, flammability of fabrics, fire resistance, color transference, water resistance, fastness to light.

J. A. Woodruff

Text. Research J. Jan. 1947

Mill Construction and Layout

Postwar mill construction and layout. India Government Planning Committee (Textiles)—Subcommittee's Report. *Indian Text. J.* **56**, 304–21 (Jan. 1946).

This is the complete report of the Subcommittee, consisting of T. V. Baddeley and Sir Frederick Stones, on "Minimum standards for buildings, spacing of machinery, lighting, humidification, and other conditions affecting the health and comfort of operatives in the postwar period." The following reports are included in the appendices: List of points to consider in selecting sites for mills, *ibid.*, 322; Safety color code for textile mills, *ibid.*, 324–7; Artificial humidification and ventilation of textile mills in India with a special reference to loom sheds, by V. A. Ajagaonkar, *ibid.*, 327–43; Air conditioning textile factories, by T. M. Shah, *ibid.*, 343–6; Carrier air-conditioning equipment for cotton mills, *ibid.*, 346–51; Humidification in Indian cotton mills, by T. Maloney, *ibid.*, 351–5; Indian Central Cotton Committee: Technological Laboratory: The effect of temperature and humidity on cotton spinning with particular reference to conditions in Bombay, *ibid.*, 355–6; Dust in cardrooms, *ibid.*, 356–7.

R. K. Worner

Text. Research J. Jan. 1947

Synthetic Fiber Insulators

Developments in rayon and silk insulators. A. G. Arend. *Silk J. Rayon World* **22**, 46, 49 (Mar. 1946).

Considerable progress was made during the war years in the substitution of manufactured fibers for silk for insulating purposes, even though the latter possesses a combination of properties and characteristics that are difficult to emulate. Nylon is said to be one of the more promising substitutes. Cellulose acetate yarn is used sometimes for switchboard wire. The regenerated cellulose rayons were also used for particular purposes but were unsatisfactory for the best magnet-wire insulation. R. K. Worner

Text. Research J. Jan. 1947

Radioactive Isotopes

Corrected tables of radioactive isotopes and their properties. Anon. *Rev. Scientific Instruments* **17**, 348–51 (Sept. 1946).

A revised compilation of the radioactive isotopes produced in the nuclear reactors of the Manhattan Project, their properties, and availability. T. J. Dietz

Text. Research J. Jan. 1947

Recovery of Process Chemicals

Recovery and utilization of process chemicals in the viscose rayon industry. Paul W. Frisk. *Rayon Text. Mo.* **27**, 461–3 (Sept. 1946).

Current practice in recovery of caustic soda, spinning-bath salts and acids, carbon bisulfide and hydrogen sulfide are reviewed briefly.

Text. Research J. Jan. 1947 J. F. Keating

German Plastic Manufacture

Progress of plastics in Germany. A report on the plastics manufactured by I. G. Farbenindustrie A. G., Leverkusen and Elberfeld, Germany. Frances J. Curtis. *Silk J. Rayon World* **21**, 31–3 (Feb. 1946). R. K. Worner

Text. Research J. Jan. 1947

Structure of Plastics

X-ray studies of the structure of plastics. W. T. Astbury. *J. Soc. Dyers and Colourists* **62**, 3 (Jan. 1946).

A lecture summary is given containing a brief discussion of the structural characteristics of 8 different plastics. Reproductions of 12 diffraction patterns are shown. Stretched polyisobutylene and contracted Vinyon are mentioned as high and low extremes of the aggregation of plastic structures.

J. A. Woodruff

Text. Research J. Jan. 1947

Plastics, Resins, and Rubbers

Plastics, resins, and rubbers. P. O. Powers. *Chem. and Eng. News* **24**, 2784–8 (Oct. 25, 1946).

Sixty-four resins, rubbers, and plastics available in the U.S. are listed in chart form. The general method of preparation and formula of the product are given, together with some of the trade names.

Text. Research J. Jan. 1947 E. F. Evans

German Rayon Production

Report on German rayon and synthetic fiber production. R. S. Krausen. *Silk J. Rayon World* **21**, 28–30, 36 (Feb. 1946).

A detailed account is given of the March, 1945, investigation of war activities of the I. G. Farbenindustrie plant at Dormagen, Germany. Production included cuprammonium rayon, synthetic upholstering material, cellulose acetate, aceto-butyrate, and contact sulfuric acid. R. K. Worner

Text. Research J. Jan. 1947

Dipping Tire Cord

Dipping of rayon tire cord. C. H. Beaver. *Rayon Text. Mo.* **27**, 467–9 (Sept. 1946).

Dipping is basically a warp-sizing operation. Descriptions of the process, equipment, and dipping solution are given. J. F. Keating

Text. Research J. Jan. 1947

Swiss Machines

Swiss machines show novel developments. Emil Honegger. *Textile World* **96**, 106–10 (Oct. 1946).

A group of pictures of new Swiss textile machinery including variable-speed spinning, automatic filling winders, hot-air slashing, and automatic looms—one of which is the Sulzer "weaving machine" in which the filling bobbin is not carried by the shuttle, allowing the use of filling wound on 4-lb. cones. Descriptive captions cover the high lights of the various machines.

H. J. Burnham

Text. Research J. Jan. 1947

Cotton Textile Workers

Work and wage experience of skilled cotton textile workers. Carrie Glasser and Bernard W. Freedman. *Monthly Labor Rev.* **63**, 8–15 (July 1946).

Interviews with 200 spinners, weavers, and loom fixers in New Bedford, Fall River, and Lewiston in June, 1945, indicated that 70% of the men and 50% of the women were 45 years of age or older. 5% had no grade-school education but half of this number had been to Americanization classes, nearly $\frac{1}{5}$ had completed no more than the 4th grade, and only 5% had had as much as one year in high school. In June, 1945, the group averaged $38.45 per week as compared with $46.35 for all manufacturing industries. Net wage after deductions for taxes and union dues averaged only $33, which would have purchased only $25 worth of goods and services at 1941 prices. These workers remained in mills because of age, seniority rights, attachment to trades and companies. Employment in northern mills suffered from southern competition before the war but it is stated that the mills may now be on an improved basis because of improved machinery and the rise of synthetics. R. B. Evans

Text. Research J. Jan. 1947

Ramie Production

Several millions in ramie investment. Hamilton Wright, Sr. *Mfrs. Record* **115**, 41–2, 56–61 (Aug. 1946).

Largest ramie development in the United States, involving an investment of several million dollars, is under way in the Everglades, Palm Beach County, Florida. Companies engaged in ramie growing and processing are named. Methods of growing, decorticating, and degumming are discussed from a practical viewpoint. R. B. Evans

Text. Research J. Jan. 1947

Rayon Manufacture

Revolution in rayon. Anon. *Fortune* **34**, 101–7, 204–10 (Sept. 1946).

Development of the continuous process of manufacturing viscose rayon is related in popular style. This process is reported to reduce the labor costs of 150-den. yarns by nearly 50%, or an estimated 4 to 5¢ per lb. Further improvements in the process, which will simplify it and increase its productivity by 30%, are reported to be on the way. Rights to use the machine elsewhere than in the United States and Latin America were recently sold to the largest English rayon manufacturer for $5,000,000, while Cuban rights were sold to another company for $1,000,000. Prewar cost for installing the process in the United States was 80¢ per lb. of capacity but this cost has risen to $1.50 or higher at present. R. B. Evans

Text. Research J. Jan. 1947

Silk Prospects

Raw silk in the American market. Judith Metzger. *Business Developments* (The Chase National Bank, Department of Financial and Business Research) **9**, 22–54 (May 8, 1946).

Trends in production, imports, manufacture, prices, and utilization of silk prior to the war are discussed in some detail. During the war, the only silk manufacture in the United States was a limited amount of government-contract work mainly on parachutes, sutures, and electrical insulation. Sericulture in Italy, China, and Japan is beginning to be re-established and raw silk imports were resumed early in 1946. Prices have been extremely high but there has been a large demand for the limited amounts available because of general shortages of textiles and high consumer purchasing power. It is held that silk will not be able to compete with synthetics on a price basis but that it may find a limited market in high-priced luxury goods such as hosiery and lingerie, for which it is preferred by some consumers. It is estimated that consumption will total not more than 9,000,000–12,000,000 lbs. per year. The appendix contains several statistical tables and a comprehensive bibliography. R. B. Evans

Text. Research J. Jan. 1947

Accident Prevention

Accident prevention in the dyeing and finishing industries. J. B. H. Morton. *J. Soc. Dyers and Colourists* **62**, 229–34 (Aug. 1946).

A survey of the problem of accident prevention in British dyeing and finishing plants. Accident statistics are presented, the various hazards discussed, and recommendations made. K. S. Campbell

Text. Research J. Jan. 1947

Damage in Drying

Fiber damages caused by drying. Christian Stritzel. *Allgem. Textil-Z.* **2**, 46–7 (1944) (through *Chem. Abstr.* **40**, 5925[9] (Oct. 10, 1946)).

The deleterious after-effects of excessive drying are described and suitable precautions for eliminating these causes of fiber damages are given.

Text. Research J. Jan. 1947

British Patent Review

Progress in rayons and rayon processing. Anon. *Silk and Rayon* **20**, 914–18 (Aug. 1946).

A brief discussion is given of the following subjects: (1) manufacture of colored viscose rayon (B.P. 576,263); (2) treatment of annular cakes of rayon yarn with liquids (B.P. 576,176); (3) production of soluble and insoluble alginate rayon fabrics (B.P. 573,058); (4) flameproofing of acetate rayon materials (B.P. 575,903). J. F. Keating

Text. Research J. Jan. 1947

Institute of Textile Technology

Research in the textile industry. Ward Delaney. *TAPPI Bull.* No. 67, 2 pp. (May 25, 1946); cf. *B.I.P.C.* **16**, 303 (through *Bull. Inst. Paper Chem.* **16**, 573 (Aug. 1946)).

The latest industry research organization in the United States is the Institute of Textile Technology chartered in 1944 by the State of Virginia as a not-for-profit educational and scientific corporation. The Institute as such and its program are described.

Text. Research J. Jan. 1947